UNISPEC™

SPECTRAL ANALYSIS SYSTEM

User Manual

© 1999 PP Systems. All Rights Reserved

PP SYSTEMS
110 HAVERHILL ROAD - STE 301
AMESBURY, MA 01913-2110
TEL (978) 834-0505 FAX (978) 834-0545

Email: support@ppsystems.com

Version 2.0.

November 30th 1999
(Last Update 06/06/02)

Table of Contents

		Page No:
	User Notice.	**1**
	Service & Warranty.	**2**
	Unpacking the UniSpec.	**3**
1.0.	**Introduction.**	**4**
2.0.	**UniSpec Hardware.**	**5**
2.1.	The UniSpec Enclosure.	5
2.1.1.	The Spectrometer.	5
2.1.2.	Halogen Light Source.	7
2.1.3.	The Battery.	8
2.1.4.	UniSpec Electronics.	8
2.2.	Foreoptics.	9
2.3.	Sample Holders / Fiber-Optic Retainers.	12
2.3.1.	Reflectance Applications.	12
2.3.2.	Absorbance/Transmission Applications.	13
2.4.	Computer.	14
3.0.	**Setting Up UniSpec.**	**15**
3.1.	Software Installation.	15
3.1.1.	Windows Software Installation.	15
3.1.2.	(Optional) DOS Software Installation.	16
3.1.3.	Installing to a HP CX1000 Palmtop PC.	16
3.2.	Setting Up UniSpec Hardware.	16
3.2.1.	Optical Connections.	17
3.2.2.	Data Connection to the PC.	21
3.2.3.	Power Connections.	21
4.0.	**UniSpec Operation Under Windows®.**	**23**
4.1.	Software Initialization.	23
4.2.	The User Interface.	24
4.2.1.	Drop-Down Menus.	25
4.2.2.	Instrument Toolbar.	37

© 1999, PP Systems

5.0.	**UniSpec Operation From a DOS PC.**	**40**
5.1.	Starting the Software.	40
5.1.1.	Starting the Software on an IBM Compatible PC.	40
5.1.2	Starting the Software on a HP Palmtop PC.	40
5.2.	Operation with a HP Palmtop PC.	41
5.3.	Transferring Data from the HP Palmtop Computer.	42
5.3.1.	PC Card Reader.	42
5.3.2.	Infrared (IR) Port.	42
5.3.3.	Serial Port Transfer.	42
5.4.	Operating the DOS Software.	44
5.4.1.	Data Menu.	45
5.4.2.	Setup Menu.	48
5.4.3.	Process Menu.	51
5.4.4.	Exit Menu.	52
5.4.5.	Quick Menu.	52
5.4.6.	Automatic Calculation of User-Defined Index Data.	53
6.0.	**Basic UniSpec Measurements.**	**55**
6.1.	Spectral Measurements.	55
6.2.	Reflectance Measurements.	56
6.2.1.	General Care of the Reference Standard.	58
6.2.2.	Cleaning the Reference Standard.	58
6.3.	Transmission/Absorption Measurements.	59
7.0.	**Maintenance.**	**60**
7.1.	Internal Halogen Source.	60
7.2.	Battery.	61
7.3.	Fuse.	62
8.0.	**Troubleshooting.**	**63**
Appendix A.	**Fiber Optic Test.**	**65**
Appendix B.	**Technical Specifications.**	**66**
Appendix C.	**UniSpec Spares & Accessories.**	**67**
Appendix D.	**Glossary of Terms.**	**70**

© 1999, PP Systems

User Notice

This instrument must not be used in situations where its failure could result in injury or death.

For applications where failure of this instrument to function correctly would lead to consequential damage, the instrument must be checked for correct operation and calibration at intervals appropriate to the criticality of the situation.

This manual is provided to help you install and operate the equipment. Every effort has been made to ensure that the information contained in this manual is accurate and complete. PP Systems does not accept liability for losses or damages resulting from the use of this information.

PP Systems' equipment warranty is limited to replacement of defective components, and does not cover injury to persons or property or other consequential damage.

This manual, and the information contained in it, is copyright to PP Systems. No part of the manual may be copied, stored, transmitted or reproduced in any way or by any means including, but not limited to, photocopying, photography, magnetic or other mechanical or electrical means, without the prior written consent of PP Systems. Exception is only made in respect of registered users downloading and printing a single copy from the PP Systems web site.

Service & Warranty

UniSpec is covered under warranty for one complete year, parts and labor are included. The instrument must be properly installed, operated and maintained in accordance with the operator's manual.

The warranty excludes all defects in equipment caused by incorrect installation, operation or maintenance, misuse, alteration and/or accident.

It is the responsibility of the customer to return goods to PP Systems or an authorized agent for repair or replacement of defective parts. For service , please contact PP Systems at:

North America:

PP Systems Inc.
241 Winter Street,
Haverhill,
MA. 01830
U.S.A.

834-0505

Tel: +1 (978) 374 1064
Fax: +1 (978) 374 0972
Email: support@ppsystems.com

Europe:

PP Systems Ltd.
Unit 2,
Glovers Court,
Bury Mead Road,
Hitchin, Hertfordshire,
SG5 1RT,
United Kingdom.

Tel: +44 1462 453 411
Fax: +44 1462 431 090
Email: support@ppsystems.com

The latest UniSpec technical information and application notes are available on the world wide web for registered users only:

http://www.ppsystems.com

© 1999, PP Systems

Unpacking the UniSpec

It is very important to check the contents of your equipment immediately upon receipt to ensure that your order is complete and that it has arrived safely. Please refer to the checklist supplied with your instrument for a detailed list of spares and accessories. Do not discard any of the packaging material until all of the items listed are accounted for.

If any of the items ordered are not included or have arrived damaged, please contact PP Systems or an authorized distributor immediately.

Please Note

It is very important that all users sign and return the enclosed "User Registration" form included with your instrument. This will ensure that your instrument is properly registered at the factory and will enable us to get directly in touch with you in the future for important update and product enhancement information.

Only registered users will be allowed access to the protected area of our website. This includes the latest manuals, software, technical information and application notes.

© 1999, PP Systems

1.0. Introduction

The UniSpec is a self contained, field portable spectrometer system. It features a high resolution spectrometer, photodiode array detector and integral halogen source.

UniSpec can be operated in a number of different configurations with a range of accessories. It is therefore suitable for use in a number of different applications. These include:

- Plant Physiology and Ecology
- Field Crop Monitoring
- Remote Sensing and Ground Truthing
- Atmospheric Science
- Industrial Applications and Process Control

It is beyond the scope of this manual to provide detailed instructions for each of these applications. Information on specific applications is available as an "Application Note" from PP Systems. This manual is intended to provide essential information about the UniSpec hardware, its configuration, maintenance and operation via the UniSpec software control interfaces.

Further technical support and application-specific information is available from PP Systems (support@ppsystems.com).

© 1999, PP Systems

2.0. UniSpec Hardware

A typical UniSpec system comprises four separate pieces of hardware:

- Unispec Enclosure,
- Foreoptics,
- Sample holder / Fiber-optic retainers,
- Computer.

It is important to understand the function of each component and their configuration prior to operating the system.

2.1. The UniSpec Enclosure.

The UniSpec Enclosure contains the system's spectrometer, light source and associated electronics.

2.1.1. The Spectrometer.

The UniSpec spectrometer incorporates a curved grating that focuses the dispersed light across a fixed 256-element photodiode array (Figure 1). Each photodiode (or pixel) is a capacitive device that discharges while it is exposed to light. During a scan, each pixel is exposed for a pre-defined time (the integration time) and the amount of charge on each capacitor measured sequentially up the array. Since this technique involves no moving parts it is fast and insensitive to vibration.

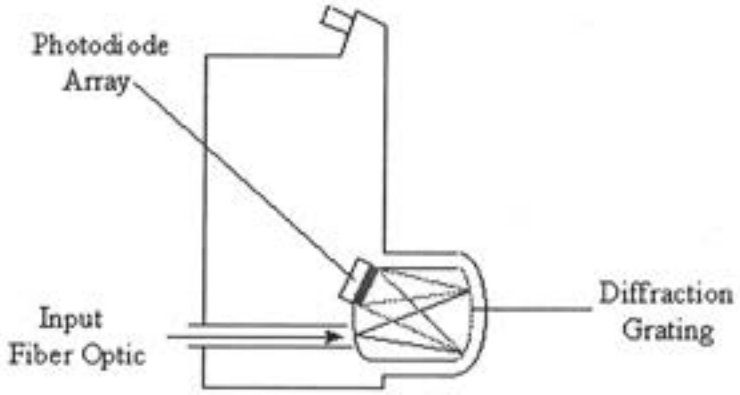

Figure 1. Diagram of the UniSpec Spectrometer.

It is important to appreciate that the spectrum (which is continuous in nature) is spread across a 256 pixel array that has discrete boundaries between each pixel. As a result, the spectrum is resolved into 256 discrete light measurements with each pixel exposed to a discrete range of wavelengths (or bin). A highly simplified version of this relationship is shown for a hypothetical four-pixel array in Figure 2.

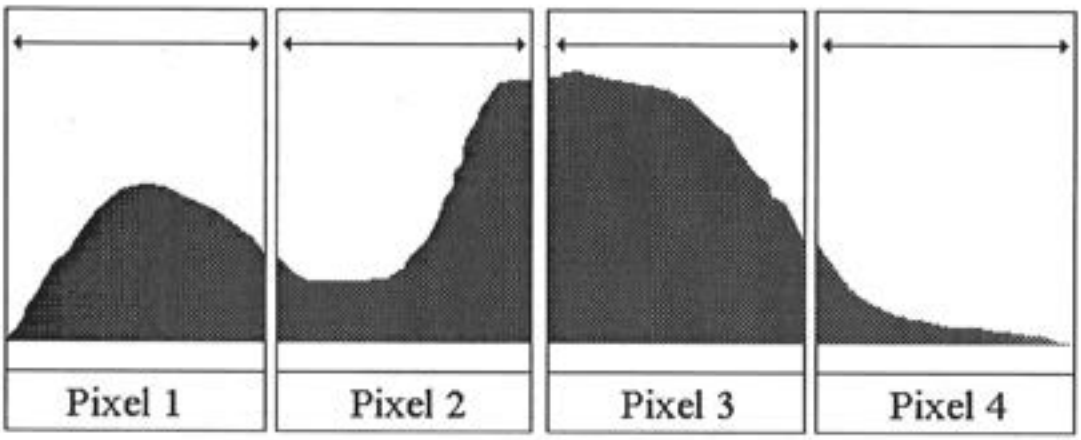

Figure 2. Pixel/Spectral Relationship for a Hypothetical Four-Pixel Array Detector.

Each pixel can be thought of as a light detector for all of the light between its two boundaries. Thus pixel 1 in Figure 2 resolves the blue part of the spectrum whilst pixel four resolves the far-red. The complete spectrometer output is a histogram of counts for each pixel in the array. In the hypothetical case above, the histogram would appear as Figure 3.

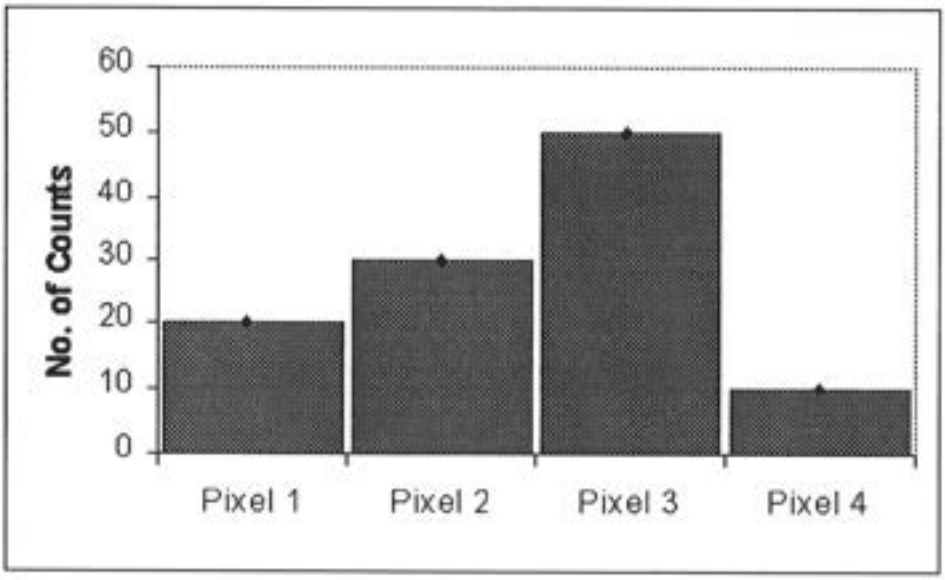

Figure 3. Photon Counts from each Pixel for a Typical Spectrum.

UniSpec Software uses this information to generate a line-plot of pixel wavelength (X) versus the intensity in ADC counts recorded per pixel (Y). Pixel wavelength is defined as the average of its two boundary wavelengths. Figure 4 shows the plot that might be generated from a hypothetical four-pixel detector that is resolving the spectrum shown in Figure 2.

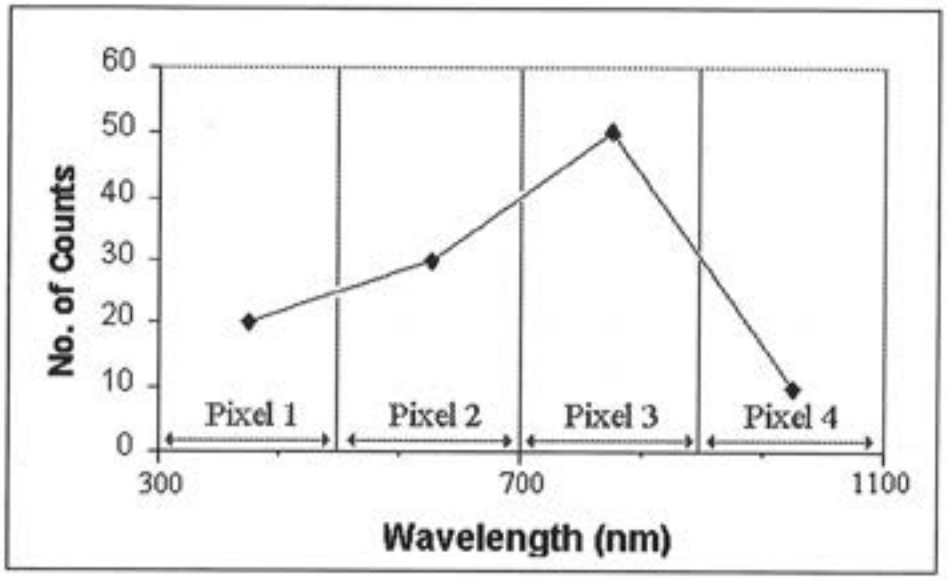

Figure 4. Typical Line-Plot of Counts versus Pixel Wavelength.

In this example, the final line-plot is an extremely crude approximation to the original input spectrum (Figure 2). This is because only four pixels were used to resolve the entire spectrum. In the case of a VIS enhanced UniSpec (300 - 1100nm), each bin would be 200nm in size. UniSpec contains 256 pixels, thus for a comparable visible light measurement, each bin would be 3.3nm.

2.1.2. Halogen Light Source.

The standard UniSpec is supplied with an integral 7.0W halogen lamp. A lens built into the envelope of the lamp focuses the output onto the end of a fiber-optic (foreoptic) when it is connected to the "Source" SMA connector. The lamp technical specifications are shown below:

Voltage	0 - 5 V
Current	1.35 A
Output (at 50mm from source)	17,000 Lux
Color Temperature	2,800 °K
Operating Life	1,500 Hours

Table 1. Technical Specifications of the UniSpec Light Source.

The lamp should not require any maintenance. Its operating life of 1,500 hours is based upon operation between 90 - 102% output. Pro-longed operation at lower settings reduces lamp life and causes a spectral shift in the output toward longer wavelengths. Instructions for lamp replacement can be found in Section 7.1. (Internal Halogen Source.).

A shutter is located in the lamp housing between the source and fiber optic termination. This enables accurate measurements of dark current to be measured at the when the instrument is temperature equilibrated during lamp operation (Section 4.2.1.1., (Dark Scan)).

2.1.3. The Battery.

The UniSpec is powered by a rechargeable 6 V, 3.4 Ah lead acid battery. This is capable of running the spectrometer continuously for a maximum of 35 hours. However, there are several factors that may significantly reduce the operating time between re-charges.

Use of the Halogen Source -	The halogen source draws considerable current; continuous operation will reduce the operating period to 2 hours.
Ambient Temperature -	Battery storage capacity is reduced at lower temperatures.
Battery Age -	Storage capacity tends to decline with age. Older batteries will require more frequent recharging.

The battery should not require any maintenance. However, it is important to recharge it after use (preferably before it is totally discharged). This is particularly important if the instrument is being stored for an extended period (two weeks or more). Storage of a discharged battery can lead to an irreversible "deep discharge" state. A completely discharged battery should take approximately 3 hours to exceed 90% charge capacity.

Each system is supplied with a spare battery. This should be fully charged and stored at room temperature. Instructions for replacing the battery can be found in Section 7.2., (Battery.).

An optional external battery pack is available for pro-longed field applications (Section 3.2.3, (Power Connections.)).

2.1.4. UniSpec Electronics.

The electronics in the UniSpec enclosure should not require any maintenance. The only user-serviceable parts are the fuse and the dark current potentiometer.

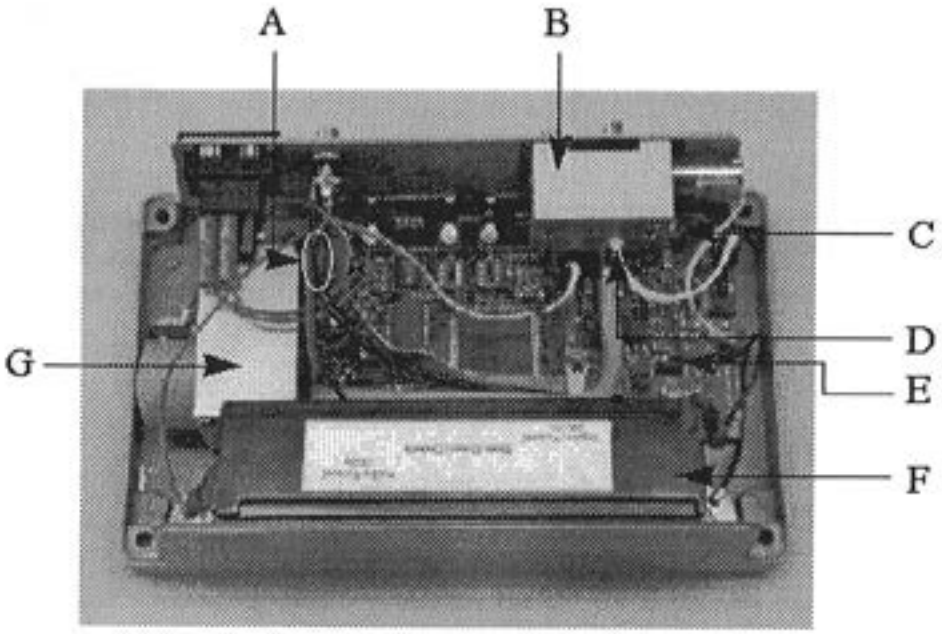

Figure 5. Internal UniSpec Layout Showing: F1 Fuse Location (A), Light Source/Shutter Housing (B), Light Source Retaining Screw (C), Light Source (D), Dark Current Potentiometer (E), Battery (F) and Spectrometer (G).

The fuse (A, Figure 5) should not require replacement under normal operating conditions. The most common reason for failure is reverse connection of the internal battery. Instructions for fuse replacement are given in Section 7.3. (Fuse.). If the fuse continues to blow following replacement it is important to seek further advice from PP Systems.

The dark current potentiometer (E, Figure 5) sets the signal baseline. It is adjusted at the factory to ensure that none of the signal is below the range of the ADC. When correctly configured, the dark current (measured with an integration time of 100ms) should be around 150 ADC counts. If necessary the potentiometer should be turned anti-clockwise to increase the reading.

2.2. Foreoptics.

The spectrometer and integral light source must be optically connected to the sample. This is achieved using fiber-optic light guides (also known as Foreoptics). These are normally glass fibers that provide a good transmission throughout the visible/NIR range (350 - 1100nm). Quartz fibers are also available for UV/visible applications; they provide good transmission between 200 and 1100nm.

A range of foreoptics configurations is available to suit both reflectance and absorption applications.

Reflectance Foreoptics.

Reflectance foreoptics are bi-furcated fiber-optics: one branch delivers light from the instrument light source to the sample whilst the second returns the reflected light to the detector. The two branches are randomly mixed at the common end to ensure that each group of fibers shares a common field of view (Figure 6).

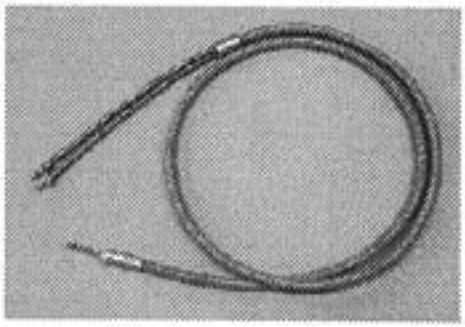

Figure 6. Reflectance Foreoptics.

At present, there are two types of reflectance foreoptics: the Standard Foreoptic is designed for measurement from large flat samples *e.g.* a broad leaf or sheets of paper, whilst the smaller Mini Foreoptic is suitable for measurement of fine samples *e.g.* tree needles or paint samples. The dimensions for each type of fiber-optic are shown in the table below:

	Measuring Diameter	Length
Standard Foreoptic	2.3 mm	1.10 m common with 15 cm legs
Mini Foreoptic	0.5 mm	1.10 m common with 15 cm legs

Table 2. Dimensions of the Reflectance Foreoptics.

Absorbance/Transmission Foreoptics.

A pair of straight fiber-optics is used for absorbance measurements. The first fiber (fiber 1, Figure 7) is used to deliver reference illumination to the sample whilst the second fiber (fiber 2, Figure 7) is placed on the opposite side to collect transmitted light. At present, straight foreoptics are available in 20, 40 and 80 inch lengths with standard SMA connectors on each end. Custom foreoptics are also available; please contact PP Systems for further details.

© 1999, PP Systems

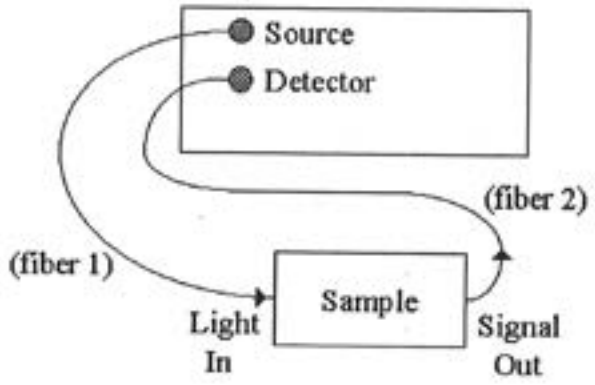

Figure 7. Typical Configuration for Absorbance Measurement.

The absorbance foreoptics are normally used in conjunction with the optional UniSpec sample cuvette holder (Section 2.3.2., (Absorbance/Transmission Applications.)). However, an absorbance/transmission probe is also available for rapid sampling of larger volume liquids.

Absorbance/Transmission Dip Probe.

The absorbance/transmission probe features a randomized, bi-furcated fiber optic. A lens fixed to the common end of the fiber collimates the reference light into a parallel beam that is passed through the open-sided probe to a mirrored surface at the probe tip. This reflects light back through the probe to the fiber-optic for transmission to the detector (Figure 8).

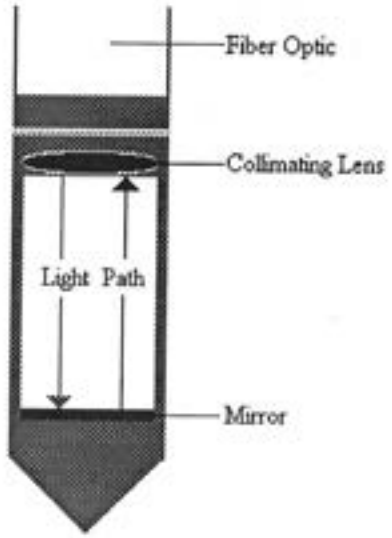

Figure 8. Absorbance/Transmission Probe.

The probe can be dipped in a fluid sample to completely fill the light path. A range of probe tips with different length light paths is available from PP Systems.

2.3. Sample Holders / Fiber-Optic Retainers.

A number of sample holders and fiber-optic retainers are available for use with UniSpec. The following retainers are designed for use in applications using the reflectance foreoptics:

2.3.1. Reflectance Applications.

During reflectance measurement (Section 6.2., (Reflectance Measurements.)) the fiber-optic must be maintained in a fixed orientation relative to the sample to get consistent results. There are three fiber-optic retainers:

Standard Clip.

The standard clip is a hinged fiber-optic retainer that is designed to allow rapid reflectance measurements from flat materials such as leaves, plastic films or papers. The fiber-optic retainer is built into the upper hinge of the clip. It holds the Standard Reflectance Foreoptic at a fixed angle of 60° and shields the sample from ambient light (Figure 9).

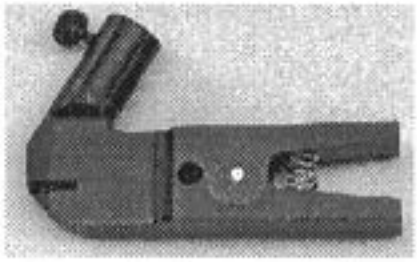

Figure 9. The Standard Clip.

Mini Clip.

The mini clip is similar to the Standard Clip. However, it is modified to accommodate the smaller diameter of the Mini Foreoptics. It also has a notch to accommodate thin samples such as needles.

Experimental Clip.

The experimental clip consists of two parts: a white detachable clip with a sliding shutter that can be used to dark adapt samples, and a black fiber optic retainer that fits over the clip (Figure 10).

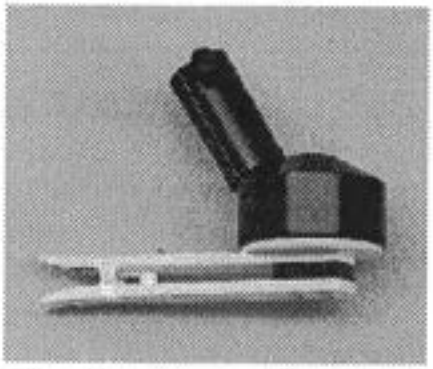

Figure 10. The Experimental Clip.

This clip is primarily intended for specialist measurements in plant physiology applications. Further information can be obtained in the UniSpec Plant Physiology Application Notes that are available from PP Systems.

2.3.2. Absorbance/Transmission Applications.

UniSpec can be configured to measure the absorbance or the transmission of fluids and solids. The optional cuvette sample holder is compatible with 4 x 1cm and 1 x 1 cm cuvettes.

The cuvette holder features a pair of collimating lenses: the first lens collimates the light input from the UniSpec source to a parallel beam inside the holder, the second lens focuses the beam onto the return foreoptic (Figure 11). Detailed instructions regarding hardware setup can be found in Section 3.2.1. (Optical Connections.).

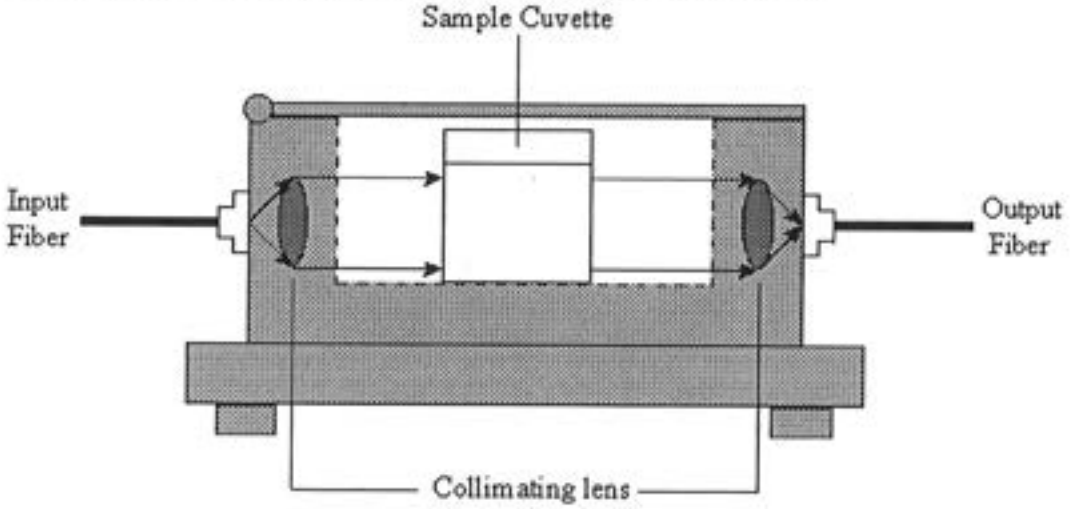

Figure 11. The Cuvette Sample Holder.

2.4. Computer.

UniSpec is controlled from a PC. The standard (UNIWIN) code runs under Windows®. This can be run on any IBM compatible PC with Windows® 3.1. or higher. An optional DOS package is available for operation from a palmtop PC during portable operation. Both software packages use an RS-232 link to the UniSpec. Instructions for software installation are given in Section 3.1. (Software Installation.).

3.0. Setting Up UniSpec

There are two steps that must be completed before the UniSpec can be operated:

- control software must be installed and configured on an appropriate PC.
- various hardware components must be connected.

3.1. Software Installation.

3.1.1. Windows Software Installation.

A copy of the UniSpec Windows® software is included with each system. It requires the following minimum PC standards:

- 386 IBM compatible PC or above,
- 4 MB RAM,
- 5MB free hard disk space,
- VGA color,Windows® 3.1 or above,
- 3½ inch floppy disc drive.

The following procedure should be used to install to Windows® 3.1., 95 and 98 systems:

1. Exit all running applications.
2. Insert disk #1 into the floppy drive.
3. Run the SETUP.EXE program from Program Manager.
4. The installation program copies initialization files before prompting for disk #2.
5. Insert disk #2.
6. The installation program prompts for a directory to install the software. The default is C:\UNIWIN. Select the "CHANGE" button to input a different directory or click the computer icon to continue with the installation.
7. The installation program will prompt for disk #3.
8. Insert disk #3.
9. Once the installation is successfully completed, a program group and UniSpec program icon are automatically created. (These items are automatically added to the Task Bar in Win95/98 operating systems).
10. UniSpec software is started by double-clicking the UniSpec program icon.
11. Finally, you need to load the calibration coefficients to match the detector in your UniSpec. To do so, insert UniWin disk #3 into your floppy drive and copy the UNISPEC.INI file from this disk to the C:\UNIWIN subdirectory on your PC. When prompted to overwrite the current file, say yes.

© 1999, PP Systems

3.1.2. (Optional) DOS Software Installation.

The UniSpec DOS software is supplied on a 3½ inch floppy disk. It contains the following files:

File:	Description:	PC:	HP 1000CX:
UNISPEC.EXE	Executable for PC	X	
U.EXE	Executable for HP		X
UNISPEC.INI	Parameter File	X	X
UNISPEC.S19	Serial Link Setup	X	X

All of the files must be copied to a UNISPEC sub-directory on the hard drive of the destination PC. The software will not run properly from the floppy drive.The following procedure can be used to achieve this:

1. At the "**C:**" prompt on the PC type "**md unispec**". [This creates the UniSpec sub-directory].
2. Insert the floppy disk and type "**A:**". [This accesses the floppy drive].
3. Type "**copy *.* c:\unispec**". [This copies all of the files to the hard drive sub-directory].
4. Type "**c:**". [This returns to the hard drive].
5. Type "**cd unispec**". [This changes to the UniSpec sub-directory].
6. The UniSpec software can be run by typing "**unispec**".

3.1.3. Installing to a HP CX1000 Palmtop PC.

A special version of the DOS software (U.EXE) is supplied with the DOS package for use on HP Palmtop computers. If the HP computer was supplied by PP Systems, it will be pre-loaded with the UniSpec software and a copy of Laplink[1] communications software. Otherwise the user will have to load the appropriate files via a PC. This will require file transfer with Laplink or some other communications utility (Section 5.3., (Transferring Data from the HP Palmtop Computer.)).

3.2. Setting Up UniSpec Hardware.

The UniSpec is a modular system so there are several possible hardware combinations. In each configuration optical, data and power connections must be made to the UniSpec rear panel (Figure 12):

[1] Laplink is a trademark of Travelling Software.

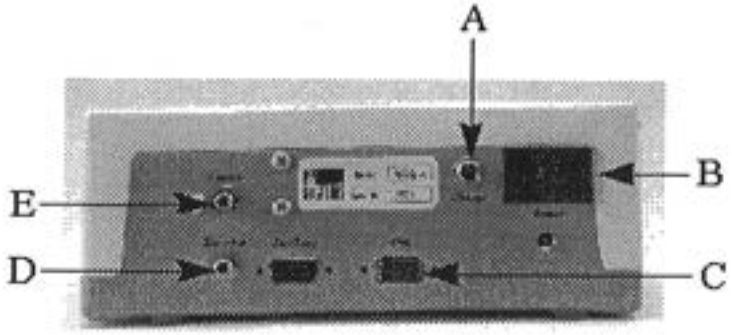

Figure 12. UniSpec Rear Panel. The following features are labeled: (A) charger connector, (B) on/off switch, (C) serial port, (D) detector fiber optic connection, (E) halogen source fiber optic connection.

3.2.1. Optical Connections.

The spectrometer and light source are optically connected to the sample with fiber optic light guides (foreoptics). These should be connected via the SMA connectors on the rear panel (Figure 12). The "Source" connector is the output from the halogen light; the "Detector" is the input to the spectrometer.

Reflectance Measurements.

During reflectance analysis, one branch of the reflectance foreoptic is used to transmit light from the instrument to the sample. The second branch carries the reflected light to the spectrometer. Both branches are randomly mixed into a common termination. As a result, either branch of the fiber optic can be connected to either SMA connection on the UniSpec.

The common end of the foreoptic is directed at the sample. It may be manually held in position or maintained in a fixed orientation with one of the optional fiber optic retainers (Section 2.3., (Sample Holders / Fiber-Optic Retainers.)). The procedure for connecting the fiber optic to the Standard or Mini Clip is given below:

1. Loosen the retaining screw on the neck of the clip (Figure 13).
2. Carefully slide the foreoptic all the way down the neck until the edge of the tip is flush with the bottom of the upper half of the clip (Figure 13). This ensures that the sample is close to the fiber tip, but will not be damaged.
3. When the fiber is in position it should be secured by tightening the retaining screw on the neck of the clip (A, Figure 13).

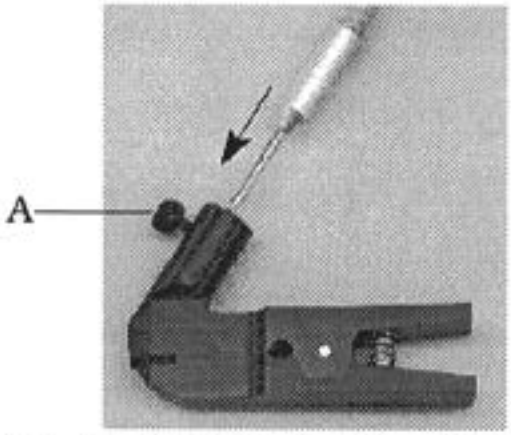

Figure 13. Foreoptic Insertion into the Standard Clip and Retaining Screw (A).

The procedure for the Experimental Clip is given below:

1. Snap the black cover over the white clip to secure it in place (Figure 14).
2. Gently rotate the black cover around the white clip to gain the most convenient location for insertion of the fiber optic.
3. Loosen the retaining screw on the neck of the black cover (Figure 14).
4. Gently slide the foreoptic down the neck of the clip until the edge of the tip is flush with the top section of the white clip (Figure 14).
5. Tighten the retaining screw to maintain the fiber optic in position (Figure 14).

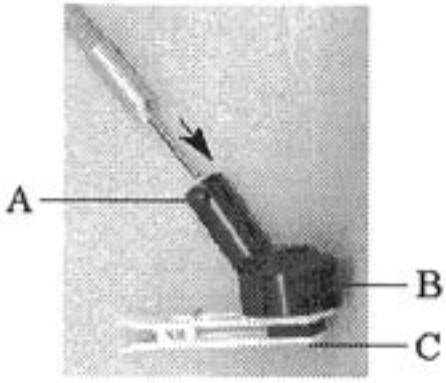

Figure 14. Foreoptic Insertion in the Experimental Clip (C). The Foreoptic is Retained in the Detachable Cover (B) by a Retaining Screw (A).

The complete optical circuit is shown in Figure 15.

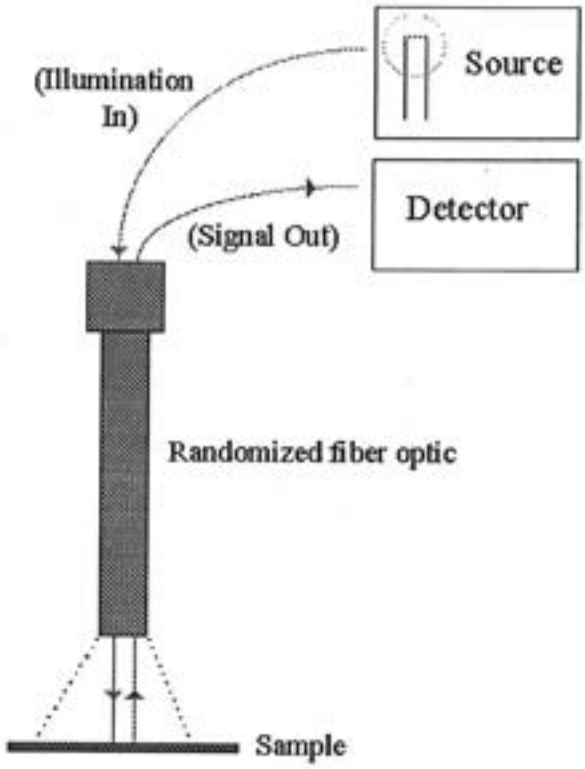

Figure 15. Reflectance Analysis Optical Circuit.

Absorbance/Transmission Measurements With the Cuvette Sample Holder.

Measurement of absorbance requires that the light output from the halogen source be passed through the sample. Typically a single straight foreoptic connects the "Source" SMA connector on the UniSpec rear panel (Figure 12) to either of the SMA connectors on the Cuvette Sample Holder (Figure 16).

Figure 16. Cuvette Sample Holder.

A second straight foreoptic connects the remaining Cuvette Sample Holder SMA connector to the "Detector" SMA connector on the UniSpec rear panel. The complete optical circuit is shown in Figure 17.

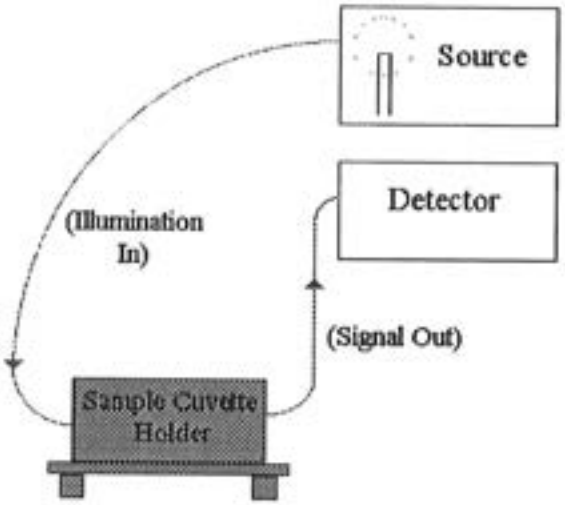

Figure 17. Absorbance Analysis Optical Circuit.

Absorbance/Transmission Measurements with the Absorbance/Transmission Probe.

The absorbance/transmission probe is similar to the reflectance foreoptic as the source and detector branches are randomly mixed at a common termination (Section 2.2., (Foreoptics.)). As a result it is not important which branch is connected to which SMA connector on the UniSpec. The optical circuit for the absorbance/transmission probe is shown in Figure 18.

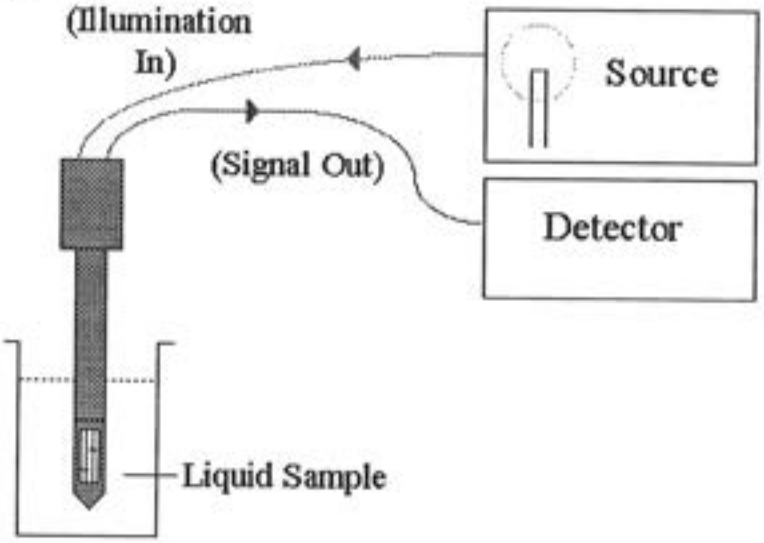

Figure 18. Absorbance/Transmission Probe Optical Circuit.

3.2.2. Data Connection to the PC.

The UniSpec must be connected to a PC for the transfer of commands and data. This is achieved by connecting the "Serial" port on the UniSpec rear panel (Figure 12) to either the "COM1" or "COM2" ports with the grey ribbon cable that is supplied with the system. It is important to note that the default software setting is for serial communication via COM1. If COM2 is used the software communication setting must be adjusted (Section 4.2.1., *Instrument Parameters* (Drop-Down Menus.)).

UniSpec may also be operated from a HP palmtop computer via the optional DOS software. These computers can be attached to the top of the UniSpec enclosure with Velcro. The serial connection should be made using the special HP RS232 interface cable that is supplied with the computer. Information regarding operation and file transfer from the palmtop is available in Section 5.2. (Operation with a HP Palmtop PC.) and Section 5.3. (Transferring Data from the HP Palmtop Computer.) respectively. Further information about the palmtop computer can be found in the HP palmtop operator's manual.

3.2.3. Power Connections.

Recharging UniSpec.

An internal lead acid battery is used to power the UniSpec (Section 2.1.3., (The Battery.)). This is charged before the instrument leaves the factory. However, storage and exposure to low temperature during transit can result in discharge. It is therefore sensible to recharge the battery prior to running the instrument. This is done by connecting the black UniSpec charger to the "Charge" socket on the UniSpec rear panel (Figure 12). It takes approximately 3 hours for a completely discharged battery to exceed 90% charge capacity.

Important Note.

! The UniSpec electronics are designed to be compatible with the charger that is supplied. Do not use a different charger without consulting PP Systems.

Optional External Battery Pack.

The optional external battery pack can be used to extend the duration of field operation before recharging becomes necessary. It comprises a 6 V 12 Ah lead acid battery that plugs into the "Charge" socket on the UniSpec rear panel (Figure 12). The procedure for recharging this system configuration is given below:

1. Connect the red spade connector to the +ve terminal of the external battery.
2. Connect the blue spade connector to the -ve terminal of the external battery.

© 1999, PP Systems

3. Connect the power plug (A, Figure 19) to the "Charge" socket on the UniSpec rear panel.
4. Connect the power plug from the standard UniSpec charger to the female receptacle (D, Figure 19) on the external battery cable.

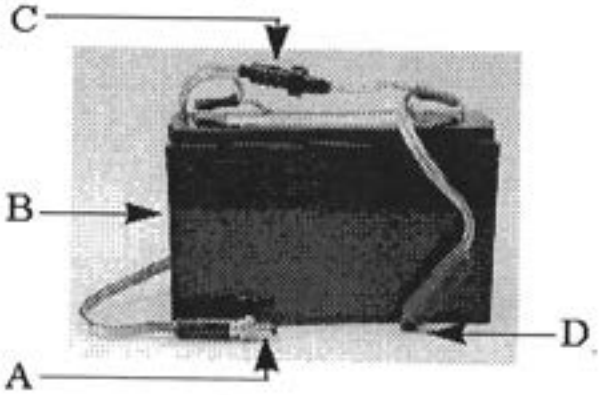

Figure 19. Optional External Battery Pack. This Comprises a 6V 12Ah battery (B), In-Line Fuse (C), UniSpec Connector (A) and Charger Connector (D).

It takes approximately 12 hours for both batteries to exceed 90% capacity, assuming that they were completely discharged. The charger self-regulates so there is no danger leaving the charger on over-night.

Important Note.

! The UniSpec lead acid battery stores a considerable amount of energy. As with all batteries, care should be taken to avoid shorting the terminals together. Metal objects must not be carried in the external battery pouch and the exposed metal of the UniSpec power connector (negative) must never come into contact with positive terminal (red) of the external battery.

© 1999, PP Systems

4.0. UniSpec Operation Under Windows®

Before operating the UniSpec, it is essential to check that the software has been installed (Section 3.1., (Software Installation.)) and that the hardware has been correctly configured (Section 3.2., (Setting Up UniSpec Hardware.)). The instrument is then controlled through either the Windows® software interface or the optional DOS program. Instructions for the DOS software are discussed in Section 5.0. (UniSpec Operation From a DOS PC.).

4.1. Software Initialization.

The UniSpec software can be used in conjunction with the UniSpec to obtain new data, or without the instrument to analyze existing files. The following procedure should be used to establish RS232 communications during operation with an instrument:

1. Connect the grey ribbon RS232 cable between the COM port on the computer and the "Serial" port on the rear panel of the UniSpec. The software default is COM1.
2. Switch on the UniSpec with the power switch on the UniSpec rear panel (Figure 12). The green LED below the power switch should flash. (Older UniSpec models do not have an LED). If the green LED was already on, the UniSpec must be re-started.
3. Double-click the UniSpec icon or select the UniSpec option from the "Start" menu (Win95, Win98).
4. The software starts by loading the introductory screen (Figure 20).

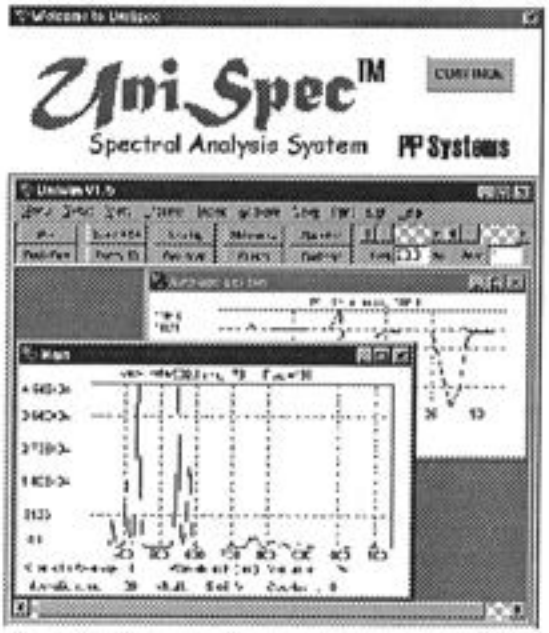

Figure 20. Introductory Screen.

5. Whilst the introductory screen loads, the software checks the RS-232 line for the presence of a UniSpec. If a UniSpec is found, the introductory screen is cleared after a few moments and the instrument performs an initial scan. The green LED on the UniSpec should stop flashing and remain continuously illuminated. This indicates that the system is ready to make measurements. See Section 6.0. (Basic UniSpec Measurements.) for a brief tutorial on the most common UniSpec measurements.
6. The operator can press the "Continue" button to close the introductory screen and move directly into the main program.
7. If a UniSpec is not found an error message is displayed. The COM port setting in the software may need to be changed (Section 4.2.1., *Instrument Parameters* (Drop-Down Menus.)) or the communications link examined. The software may still be used to open existing UniSpec files.

4.2. The User Interface.

The UniSpec user interface comprises three functional areas:

1. Drop-Down Menus (A, Figure 21)
2. Instrument Toolbar (B, Figure 21)
3. Data Presentation Area (C, Figure 21)

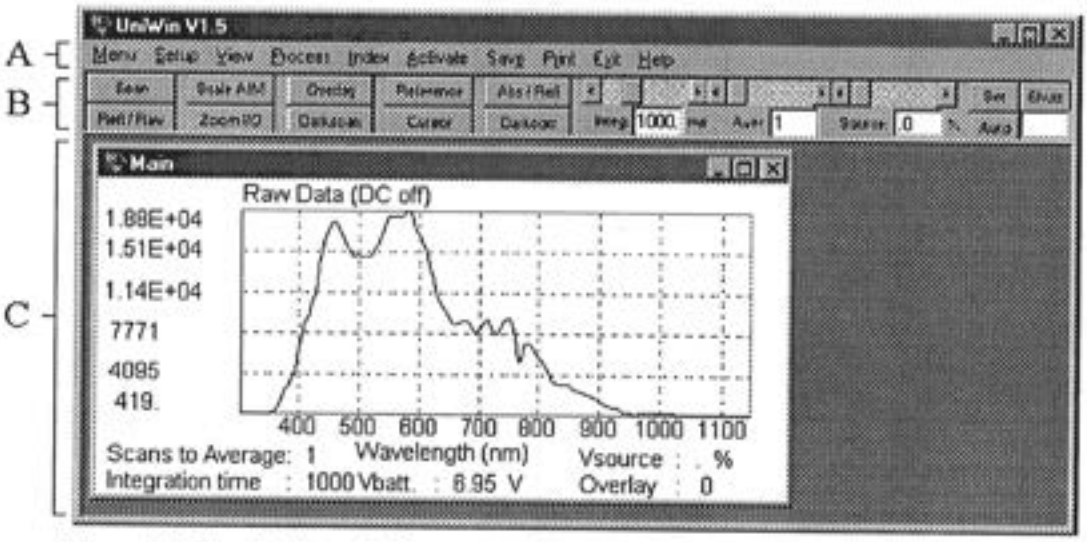

Figure 21. The UniSpec Software Interface, featuring Drop-Down Menus (A), Instrument Toolbar (B) and Data Presentation Area (C).

4.2.1. Drop-Down Menus.

The Drop-Down menus contain all of the software/hardware configuration functions and file handling options. There are ten main menu options, each has an "accelerator" key associated with it. This is the bold, underlined letter in the menu title. The menu can be opened by pressing the "ALT" + accelerator key simultaneously (*e.g.* the Setup menu is accessed by pressing "ALT" + "M").

Menu	Setup	View	Process	Index	Activate	Save	Print	Exit	Help

Individual menu items also have accelerator keys associated with them. Once a menu is open the appropriate accelerator key can be pressed to initiate a feature or command.

4.2.1.1. Menu.

The Menu option controls the acquisition of new data and file storage functions. It contains the following sub-menus:

Menu	
	Scan
	Dark Scan
	Reference Scan
	Auto Scan
	Overlay Scan
	Cursor
	Save File
	Read File
	Overlay File
	Erase

Scan.

The UniSpec scans on a continuous basis whilst it is switched on. When the Scan option is selected, the present scan is captured and displayed in the "Main" window in the Data Presentation Area. The time required to complete this operation will depend how far the UniSpec was into its scan cycle when the Scan option was selected.

Dark Scan.

Each of the pixels in the detector array is a capacitive device that discharges in the presence of light. There is some loss of charge, even in the absence of light - the "dark current". Under most circumstances, the dark current will be very small in comparison to the light induced discharge. However, that may not be the case in the extreme UV and IR

regions where the detector sensitivity is considerably reduced. The UniSpec software has a correction facility to automatically subtract the dark current from the spectral data.

The Dark Scan option initiates a dark scan. During the scan it is important to ensure that no light enters the spectrometer; this is achieved by completely covering the fiber optic and closing the shutter. The dark scan is stored in PC memory, and automatically subtracted from all subsequent scans (including reference and auto scans) if the correction is toggled on with the Darkcorr button or the setup options menu. A Dark Scan will be stored, even if the Dark Correction is turned off.

The dark current varies with integration time and scan averaging. If these settings are changed, the dark current must be re-measured. It is also important to note that the dark current is affected by changes in temperature; for better accuracy the dark scan should be re-measured if the ambient operating temperature changes.

The datapoints in the darkscan should be scattered around an approximately straight line (Figure 22). If this is not the case, light might have entered during the dark scan. The Dark Current is factory set to about 100 counts at the shortest Integration Time. The hardware will need to be adjusted using the dark scan potentiometer (D, Figure 5) if the dark current is significantly smaller than this.

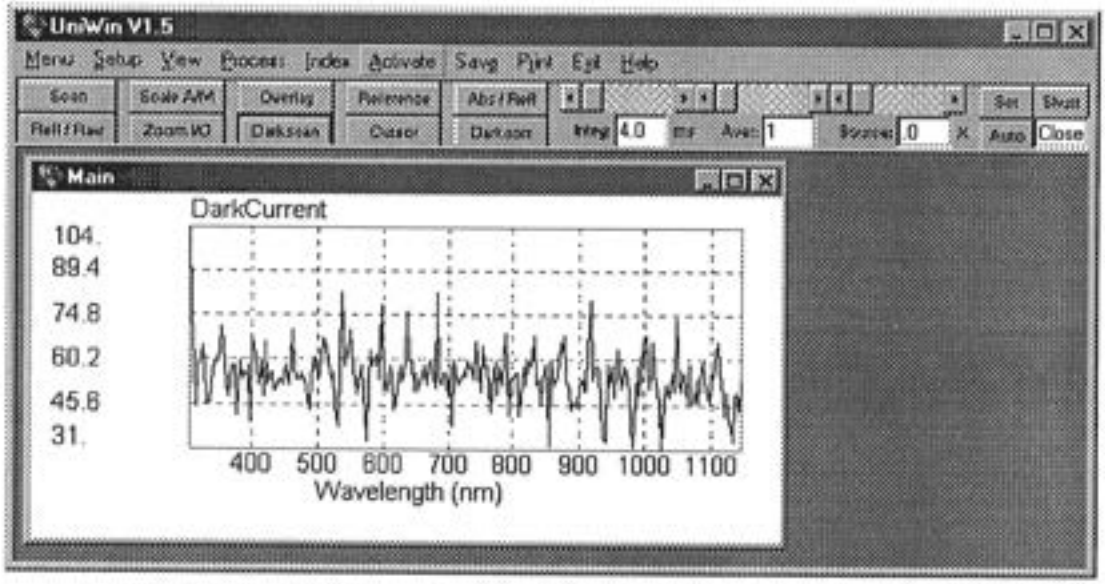

Figure 22. Typical Dark Scan (Integration Time = 4ms).

Reference Scan.

The reference scan initiates and stores a scan for use as a reference during Reflectance and Absorbance/Transmission calculations (Section 6.2., (Reflectance Measurements.) and Section 6.3., (Transmission/Absorption Measurements.) respectively).

During reflectance analysis, the sample scan of a surface is compared to a reference scan of a white (close to 100%) reflective surface. During Absorbance analysis, the sample scan is compared to a reference scan with the medium removed.

A Reference Scan will be stored, even if Reflectance and Absorbance are turned off. The Reference Scan is automatically corrected for Dark Current if the Dark Correction feature is active.

Auto Scan.

The UniSpec can be configured to scan data at pre-set time intervals (0.5 - 86,400 sec). This feature is initiated with the Autoscan option in the Menu group and cancelled with the ESCAPE key.

Auto Scan can be used in conjunction with the Time Stamp function to label each scan with the time. The timer is set to zero with the first Auto Scan. Subsequent stopping / re-starting of Auto Scan does not re-set the timer. The Erase function must be used to clear data and re-set the timer.

The Auto Save function can also be used to write each scan, and any active indexes, to a file on disk automatically.

Overlay Scan.

This function initiates a new scan without removing the existing plot(s) from the "Main" window. A series of up to eight scans may be displayed simultaneously. Any additional scans will replace the first scans in the series. If the Autoscale function is selected, the vertical scale will be adjusted to suit the most recent plot in the series.

The Erase function should be used to clear the "Main" window.

Cursor.

The Cursor function places a vertical cursor on the "Main" window that can be moved along the trace with the mouse, left/right keys or page up/page down keys (Figure 23). The arrow keys move the cursor one pixel at a time, the page keys move twenty pixels at a time. X-Y co-ordinate readings of intensity versus wavelength and pixel number are displayed above the plot.

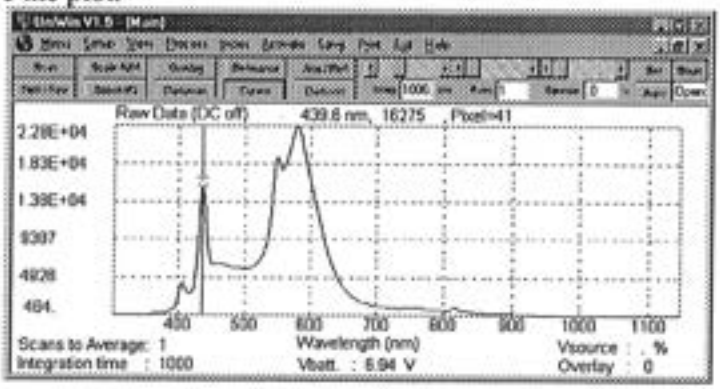

Figure 23. Reading X - Y co-ordinates with the Cursor Function.

Clicking the Cursor function a second time removes the cursor.

Save File.

Scans can be stored to disk using the Save File function. The following prompt box (Figure 24) requests a file name and file path for storage. All scan files are stored with the *.SPU file extension. (DOS software prior to version 2.6 have a *.SPT file extension which is not compatible with the current version of software.). Memory also contains any index data that has been accumulated since the last Save File or Erase operation. The Save File Function also transfers active indexes data from memory to temporary index files (*.TMP).

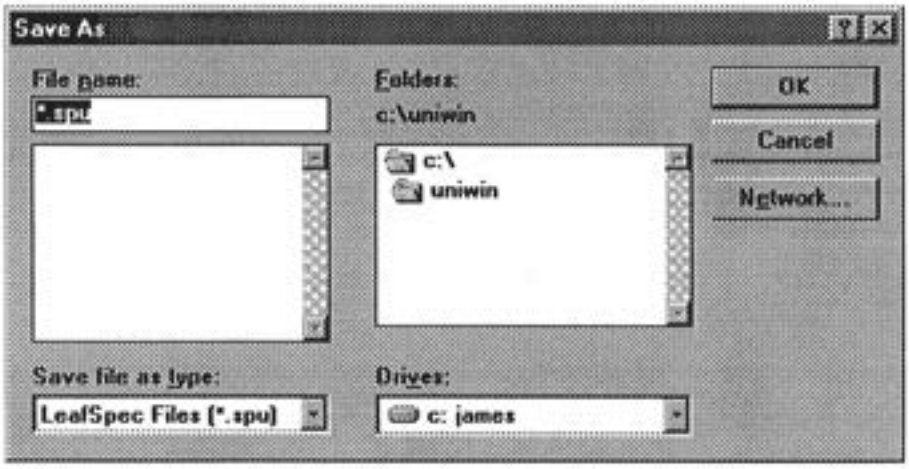

Figure 24. Save File Prompt Box.

Read File.

Previously stored scans can be read and plotted with the Read File function. The following prompt box requests the file location and file name (Figure 25).

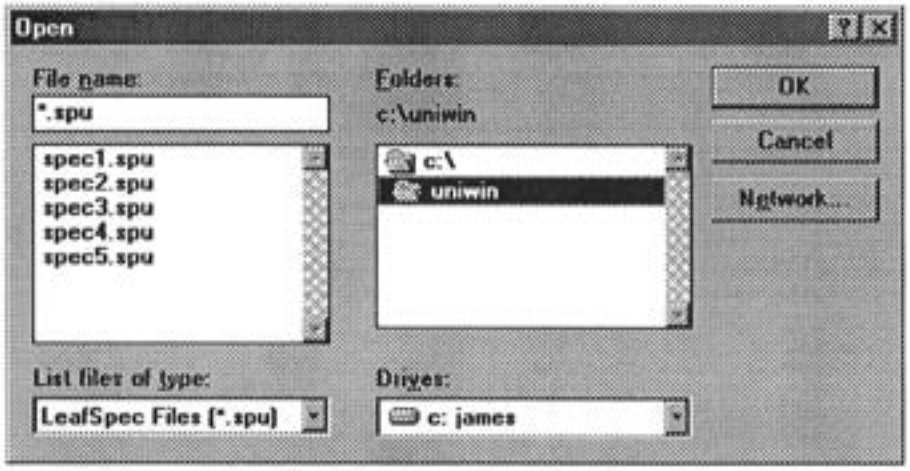

Figure 25. Read File Prompt box.

Overlay File.

This function reads a stored file from disc without removing the existing plot from the "Main" window. Any number of files may be overlaid.

Erase.

Clears all plots from the "Data Presentation Area" and re-sets the timer. All spectral data, including the Reference and Dark Current spectra are cleared.

4.2.1.2. Setup.

The Setup menu contains features to configure both hardware and software. The following options are available:

Setup	
	Auto Set Integration Time
	Options
	Set Scale
	Instrument Parameters
	Default Data Directory
	Reference Calibration File

Auto Set Integration Time.

The integration time defines the detector exposure period during each scan. Ideally the integration time should be set so that the measured signal is a little smaller than the maximum signal acceptable by the ADC (65,535 counts). The Auto Set feature sets the integration time so that the highest spectral intensity is 75% of the A/D range of the instrument. The longest integration time that is automatically set is 1000ms. Longer times can be set manually (Section 4.2.2., (Instrument Toolbar.)).

Options.

The Options feature loads the following menu (Figure 26).

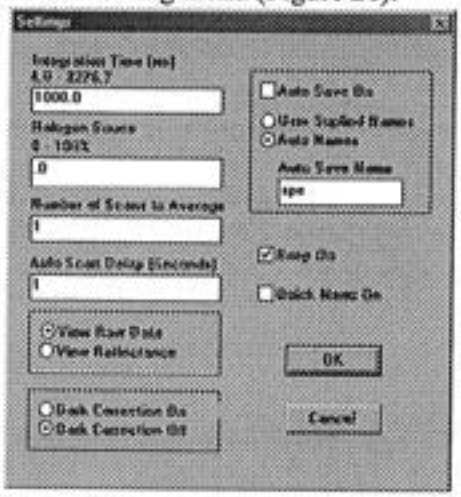

Figure 26. Options Menu.

This menu replicates many of the instrument toolbar settings (Section 4.2.2., (Instrument Toolbar.)); it allows access to the following settings:

1. Integration Time - Defines the exposure duration of the detector (4 - 3276 ms). The total scan time (*i.e.* integration time x no. of Scans to Average) is limited to 4 s. If this scan time is exceeded, the scan averaging is reduced accordingly.

2. Halogen Source - Controls the voltage supplied to the halogen lamp (7 - 102.3%). The highest setting runs the lamp at 2.3% above its rated voltage. The lamp life is longest when it is run above 90%.

   Any setting above 7% will also trigger the internal cooling fan. (Not applicable to older UniSpecs). This minimizes the warming effect of the lamp. However, if the lamp is used for a pro-longed period it is advisable to re-measure the dark current regularly, as it is temperature dependent.

3. No. of Scans to Average - Sets the Number of Scans to Average for a single measurement (1 - 1,000) scans. The total scan time is limited to 4 s. If the product of Integration Time and Number of Scans to Average exceeds this value, the Number of Scans to Average is automatically reduced.

4. Auto Scan Delay - Defines the period between scans when the Auto Scan function is used. Values between 0.5 and 86,400 sec (1 day) may be entered.

5. Auto Save - Enables the instrument to automatically save scans. The software can be configured to prompt after each scan for a user-defined filename or assign a filename using the following rules:

   The operator can pre-define a 3 character Auto Save Name; this is automatically extended with a 5 digit number. The number starts at 00000 and increments with each subsequent scan. As a result a maximum of 100,000 files can be stored in the default data directory. All files are given the *.SPU extension.

   Any active indexes will be temporarily saved in *.TMP files during scanning. Each index should be saved separately to disk at the end of each measurement sequence using the Save menu option. Index files are given a *.DAT file extension. If the index data is not saved, it will remain in the *.TMP file until it is saved, further data will be appended to the *.TMP files.

6. View Reflectance / Raw Data - Raw Data displays the intensity values that are recorded directly from the spectrometer (0 to 65535). If the dark correction is activated previously stored values of dark current are automatically subtracted from the scan before the data is presented.

   The Reflectance Data option displays the ratio of the present scan and a previously stored reference scan (generally 0 to 1).

7. Dark Correction - The Dark Current Correction automatically subtracts a previous measurement of the dark current from all subsequent scans. This feature is used to separate the measured light signal from an inherent detector signal that is generated even in the dark. For more information see Section 4.2.1.1., (Menu.).

8. Beep Option - Toggles a beep at the end of each measurement on/off.

9. Quick Menu - Toggles a short cut menu on/off.

Set Scale.

The Set Scale menu (Figure 27) can be used to manually set the Y-axis of all data plots for each of the data windows or switch to automatic scaling.

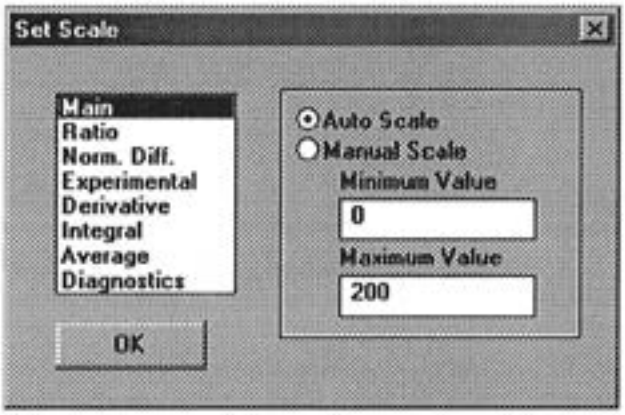

Figure 27. Set Scale Menu.

Instrument Parameters.

The Instrument Parameters menu contains the instrument calibration parameters and the COM port selection switch (Figure 28). It also allows a simulated spectrum to be displayed if no UniSpec is connected. A file with the name "simulate.spu" should reside in the default directory.

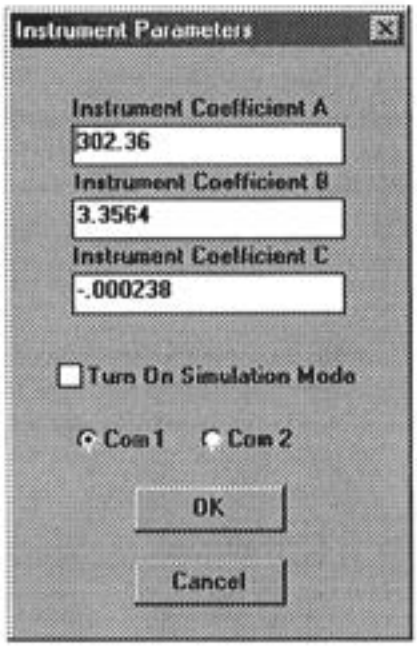

Figure 28. Instrument Parameters Menu.

The instrument calibration consists of three spectrometer coefficients (A, B and C), that map the pixel number in the detector array (p) to wavelength (λ) via a 2nd order polynomial.

$$\lambda = A\,p2 + B\,p + C$$

Each coefficient is set at the factory during calibration. They should remain valid over the lifetime of the spectrometer, and should **NOT** be changed. The spectral calibration can be readily checked by sampling the spectral output from a radiation source with known absorption features *e.g.* a mercury argon lamp. Typically, each spectral peak should be within 1 to 2nm of the expected position.

A new calibration can be calculated by making a table of known wavelength for each feature versus pixel number in the detector. Then fit a second-degree polynomial to the data.

This yields an intercept value (C) and two additional coefficients (A and B). These should be entered into the appropriate instrument parameter boxes to update the calibration.

The COM port switch can be used to define the PC serial port that the software uses to communicate with the UniSpec. The default setting is COM1. However, if this port is used by another device COM2 can be used.

Default Data Directory.

This option allows the operator to define a default data storage directory. The standard setting is C:\UNIWIN.

Reference Calibration File.

During reflectance analysis, the reflected light from a sample is compared to the light reflected from a white reflectance standard (Section 6.2., (Reflectance Measurements.)). If measurements are being made outside of the laboratory, it is advisable to keep two reference standards: one as a primary standard that is kept in the laboratory and one as a secondary standard that is used in the field.

The secondary standard will inevitably become dirty and deteriorate. It should therefore be regularly cross-referenced to the primary standard. The reference calibration file can be used to store the relationship between the two standards. The operating procedure is as follows:

1. Set the light source to 100%.
2. Allow the lamp to warm up a few seconds
3. Scan the primary reference by pressing the Reference button.
4. Scan the secondary reference by pressing the Scan button
5. Save the secondary reference scan to disk.
6. Select the Reference Calibration File option from the Setup group on the drop down menu.
7. Check the Reference Calibration File check box and define the reference file name and path.

Once this is set the UniSpec software will determine the relationship between the primary and secondary references and correct data from Reference scans of the secondary standard so that it relates to the primary standard.

4.2.1.3. View.

The view menu is used to select which UniSpec data windows are displayed. Displayed windows are labeled with a check mark. They may be activated / de-activated by clicking on them.

The Tile Windows function can be used to organize the currently selected windows on the screen.

4.2.1.4. Process.

UniSpec software contains several mathematical operations for analyzing saved scan data.

Divide	- divides one scan by another.
Add	- calculates the sum of two scans.
Subtract	- subtracts one scan from another.
Multiply	- calculates the product of two scans..
Average	- calculates the average of multiple scans.
Derivative	- calculates derivatives of the current scan.
Transform	- transforms a pair of scans in the following manner with three user-defined coefficients. A*File1 + B*File 2 + C

The basic mathematical operations (Divide, Add, Subtract and Multiply) require the user to specify two files, and the type of data to be used in the operation. The following dialog box is presented (Figure 29).

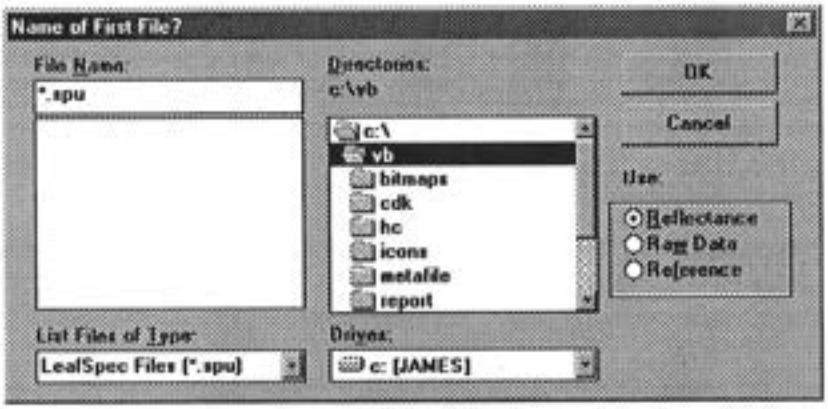

Figure 29. File Specification Dialog Box.

Multiple files may be selected for averaging with the Average function. This generates the "Files to Average" dialog box (Figure 30) which is used define the directory path and select files. Individual files are selected by double-clicking the appropriate filename in the "Files Box". Selected filenames are copied to the "Files to Average" box. The "Calculate Standard Errors" box can be checked to automatically calculate and plot standard errors. These are plotted as red and green lines above and below the averaged data.

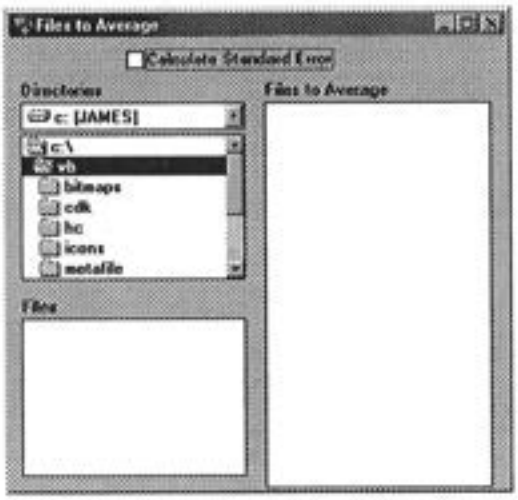

Figure 30. Files to Average Dialog Box.

The Transform feature generates the "Transform Values" dialog box (Figure 31). This is used to enter user defined parameter values from the transformation. Once complete the user is prompted to select the pair of data files that are used in the calculation.

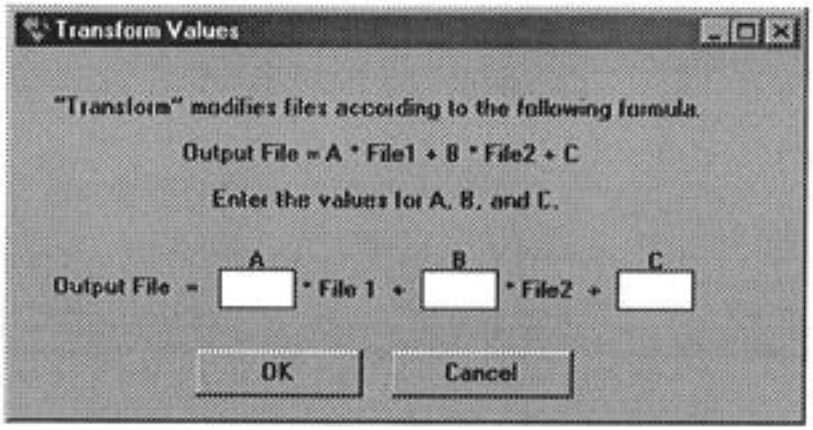

Figure 31. Transform Values Dialog Box.

4.2.1.4. Index.

The Index menu contains options to define wavelength bands and indexes. Once an index has been defined, the software may be configured to automatically calculate and display the index each time a measurement is made. There are two stages to defining an index calculation. The first is to define the wavelengths that are used in the index calculation, the second is to define the index calculation itself.

Defining Wavelengths.

Each index calculation requires the definition of bands *e.g.* a calculation of the red / far red ratio requires that the red and far red wavelength bands be defined.

A maximum of 100 wavelength bands may be defined; each one has a starting wavelength (Band Start) and ending wavelength (Band End). The range can be anywhere within the range of the spectrometer. Appropriate values should be entered in the prompt box that is generated.

Defining Index Calculations (Kinetic Definitions).

An Index is the result of a mathematical operation on one or more wavelength bands. The UniSpec software can be used to calculate six different types of index. Each index must be defined with the wavelength band(s) and mathematical operators (experimental index only). Once checked in the View and Activate menus, (Section 4.2.1., (Drop-Down Menus.)), each index is plotted against time in its own window each time a scan is made. The different types of index are defined in the "Kinetic Definitions" dialog box (Figure 32).

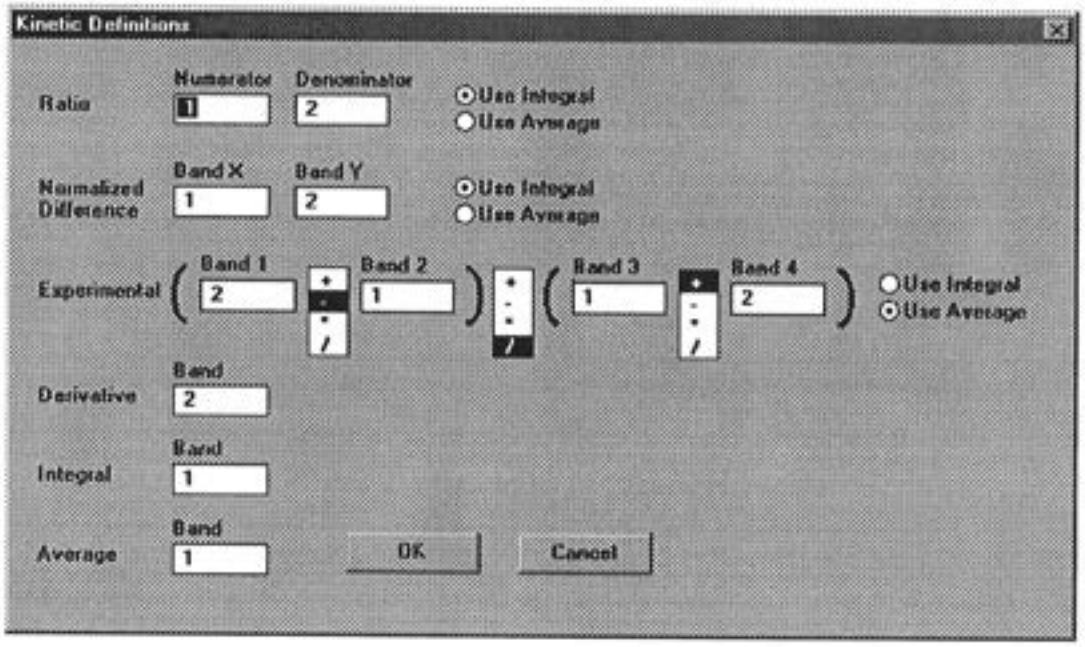

Figure 32. Kinetic Definitions Dialog Box.

4.2.1.5. Activate.

Each of the index functions must be activated before calculations are displayed. The Activate function lists each of the available index types. Required indexes should be clicked to change their status (checked indexes are active).

The Time Stamp can be activated to record the time since the system started up or the data plots were last cleared with the Erase function. It is only used in conjunction with the Auto scan feature (Section 4.2.1.1., (Auto Scan.)).

4.2.1.6. Save.

Data from each index calculation is temporarily stored in a *.TMP file whilst measurements are being made. The Save function should be used to permanently save a selected index data to disk. It effectively copies the appropriate *.TMP file to a user-defined *.DAT file. The contents of the *.TMP file are automatically cleared after the *.DAT file has been created.

4.2.1.7. Print.

The Print function should be used to dump data to the currently selected Windows® printer. The following prompt box allows the user to select the data window for printing (Figure 33). Multiple items may be selected to be included in a single print job.

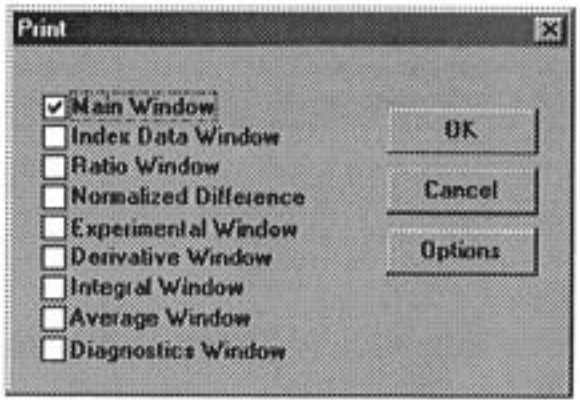

Figure 33. Print Dialog Box.

The size of print may be adjusted between 75 - 125% from the Options button.

4.2.1.8. Exit.

This function terminates and closes the UniSpec software. Configuration parameters are saved to a *.INI file and the *.TMP file is written to disk.

4.2.1.9. Help.

The Help function contains two options: the Help option opens the on-line help facilities, the About option lists software version information. It is helpful to have this information available when contacting PP Systems for technical support.

4.2.2. Instrument Toolbar.

The instrument toolbar contains features to set instrument parameters, toggle between measurement modes and initiate scans (Figure 34). Most of these features duplicate drop-down menu functions. However, they are presented on the instrument toolbar to aid access during measurement.

Figure 34. Instrument Toolbar.

4.2.2.1. "Scan" Button.

When the Scan option is selected the present scan is captured and displayed in the Data Presentation Area of the "Main" window. Further information is available in section 4.2.1.1. (Scan.).

4.2.2.2. "Refl/Raw" Button.

The default mode for data presentation is the "raw" mode where data is plotted as counts versus wavelength. During reflectance analysis the ratio of each scan to a white reflectance standard is calculated. The "Refl/Raw" button toggles between these modes. Further information on reflectance analysis can be found in Section 6.2. (Reflectance Measurements.).

4.2.2.3. "Scale A/M" Button.

Toggles between automatic and manual axis settings in the Data Presentation Area section 4.2.1.2., (Setup.)).

4.2.2.4. "Zoom I/O" Button.

The "Zoom I/O" button can be used to expand the wavelength scale in a specified region. The following procedure should be used:

1. Use the mouse to move the cursor to the starting wavelength.
2. Hold down the left mouse button and drag the cursor to the end wavelength.
3. Release the mouse button.
4. Press the "Zoom I/O" button to zoom in, press again to zoom out.

The zoom function cannot be used whilst the Cursor function (Section 4.2.1.1., (Cursor.)) is enabled.

4.2.2.5. "Overlay" Button.

This button initiates a scan without removing the existing data from the data presentation windows. A maximum of eight scans may be displayed simultaneously.

4.2.2.6. "Darkscan" Button.

The "Darkscan" button initiates a scan and stores the data as a "dark scan". It is important to ensure that no light enters the spectrometer during the scan. Further information can be found in Section 4.2.1.1. (Dark Scan.).

4.2.2.7. "Reference" Button.

The "Reference" initiates and stores a reference scan for use during Reflectance and Absorbance calculations (Section 6.0., (Basic UniSpec Measurements.)).

4.2.2.8. "Cursor" Button.

The cursor function places a vertical cursor in the Main window that can be moved along the trace with the mouse, left/right or page up/page down keys (Section 4.2.1.1., (Cursor.).

4.2.2.9. "Abs/Refl" Button.

This button switches between absorption and reflectance measurement modes. Further information about these modes of operation can be found in Section 6.0. (Basic UniSpec Measurements.).

4.2.2.10. "Darkcorr" Button.

The "Darkcorr" button toggles the dark correction calculation on/off.

4.2.2.11. Integration Time Scroll Bar.

The integration time may be adjusted by moving the integration time scroll bar, or by typing the time (in ms) in the text box beneath. The new settings are registered by clicking the "Set" button.

4.2.2.12. Scan Averaging Scroll Bar.

The scan averaging can be set with the scroll bar, or by entering an appropriate number in the text box beneath. Any change in settings must be registered by clicking the "Set" button on the instrument toolbar.

4.2.2.13. Halogen Source Scroll Bar.

UniSpec's halogen source voltage can be set from the instrument toolbar. The setting can be adjusted (0 - 102.3%) by sliding the halogen source scroll bar or by entering an appropriate setting in the text box beneath. Settings are only registered in the software once the "Set" button has been clicked on the instrument toolbar.

4.2.2.14. "Set" Button.

Any new instrument control values (integration time, averaging and source voltage) must be registered before they will take effect. Clicking the "Set" button does this.

4.2.2.15. Shutter Control.

The shutter can be used to prevent transmission of light from the halogen source to the sample without any of the temperature changes associated with switching the lamp off. Hence, this is ideal for accurate determination of "dark current". The shutter is toggled between the open and closed position by clicking the "Shutt" button. The current shutter status is displayed in a text box beneath the "Shutt" button.

4.2.2.16. "Auto" Button.

The integration time is automatically set so that the highest spectral intensity is 75% of the full-scale range (65,535 ADC counts).

5.0. UniSpec Operation From a DOS PC.

Optional DOS software is available to enable UniSpec operation from an HP palmtop under field conditions or from a DOS PC in the laboratory. There are two versions of the software: UNISPEC.EXE that is designed for operation on a full size IBM compatible PC and U.EXE which is configured specifically for operation on a HP 1000CX or HP 200LX palmtop PC. The installation procedure is described in Section 3.1. (Software Installation.).

5.1. Starting the Software.

5.1.1. Starting the Software on an IBM Compatible PC.

The following procedure should be followed:

1. Connect the grey ribbon RS232 cable between COM1 and the "Serial" port on the UniSpec rear panel (Figure 12). (N.B. COM1 is the factory default setting that must be used when the system is first initialized. The port setting can be changed to COM2 after initial start up if required (Section 4.2.1.2., (Instrument Parameters.)).
2. Switch the UniSpec on with the "Power" switch on the rear panel (Figure 12). The green LED should flash. (Earlier UniSpec units do not have a green LED).
3. Switch from the root directory to the "UNISPEC" sub-directory by typing "**cd unispec**" and pressing the "ENTER" key.
4. Run the UniSpec software by typing "**unispec**" and pressing the "ENTER" key.
5. After 2 -3 seconds the system should prompt to check whether the UniSpec is connected. Press the "Y" key to continue. The green LED should stop flashing and remain continuously illuminated.
6. Press the "N" key to perform a scan and check that the instrument is functioning. If a scan does not appear after there is a communications problem. Troubleshooting information can be found in Section 8.0. (Troubleshooting.).

5.1.2. Starting the Software on a HP Palmtop PC.

The HP palmtop computer can be mounted directly on top of the UniSpec with Velcro fastener. The following procedure should be used to start the UniSpec Software:

1. Connect the special HP-UniSpec serial cable from the COM port in the right hand side of the HP Palmtop to the "Serial" port on the rear panel of the UniSpec (Figure 12).

2. Switch on the UniSpec with the "Power" switch. The green LED beneath the power switch should flash (Figure 12). (Earlier UniSpec models may not have a green LED).
3. Change to the UNIPSEC sub-directory on the HP Palmtop (from the root directory type "**cd unispec**", then press "ENTER").
4. Run the UniSpec software by typing "**U**", then press ENTER.
5. After 10 - 15 seconds a prompt will ask whether the UniSpec is connected. Press "Y" to continue. The green LED on the UniSpec should flash at a lower intensity whilst communication is established.
6. The main menu will then load. The "**N**" key can be pressed to initiate a scan. The green LED should no longer flash, indicating that communication is in progress. If a scan does not appear (or the green LED continues to flash), there is a communications problem. Further "troubleshooting" information can be found in Section 8.0. (Troubleshooting.).

Instructions regarding HP palmtop operation can be found in the HP Palmtop Operator's Manual. There are several points that must be observed to protect data.

5.2. Operation with a HP Palmtop PC.

Although the HP Palmtop is a full PC, there are several major differences from a conventional desktop or laptop PC:

- The screen resolution is reduced to monochrome CGA mode and the screen is not backlit. This may restrict indoor operation but should allow field operation under bright ambient conditions.
- The HP Palmtop is considerably slower than a standard PC. It takes approximately 4 seconds to scan and plot a spectrum on the HP palmtop, versus approximately 1 second on a typical 486 computer.
- HP Palmtop computer has a suspend facility that shuts the computer down if it is left idle for more than 3 minutes (determined by the HP setup options). The UniSpec software may be resumed by pressing the "ON" button. No data will be lost provided the batteries are in good condition.
- A pair of "AA" alkaline or NiCd batteries powers the HP Palmtop computer. Alkaline batteries should last for approximately 50 hours in continuous use. NiCd batteries have a shorter operation period but they can be re-charged for re-use. In either case, the computer automatically shuts down when the voltage output drops below 2.4 V. The UniSpec software will terminate when the "AA" batteries are removed and the last unsaved scan will be permanently lost. A lithium backup battery protects saved data. This should be maintained in accordance with the HP Palmtop Operator's Manual.

  PCMCIA Memory cards are available for the HP Palmtop computer to store data. These use flash ROM and do not require a back-up battery. If these are unavailable data can be transferred to a standard PC using RS-232 transfer software (Section 5.3., (Transferring Data from the HP Palmtop Computer.)).

5.3. Transferring Data from the HP Palmtop Computer.

There are three methods that can be used to transfer data from the palmtop computer to another PC:

1. PC Card Reader,
2. Infrared (IR) Port,
3. Serial Port Transfer.

5.3.1. PC Card Reader.

The PCMCIA cards that are available for the HP Palmtop can be read via a PCMCIA card reader on a standard PC. It is recommended that both the HP Palmtop and the recipient PC should be switched off whilst the memory card is switched between computers.

5.3.2. Infrared (IR) Port.

An infrared port is located in the side of the HP computer. This can be used to transfer data to a laptop computer with a similar port. Further information can be obtained from the HP Palmtop Operator's Manual.

5.3.3. Serial Port Transfer.

Data is normally transferred via serial port communication. This requires appropriate communications software to be operating on both computers. There are two common programs:

- Transfile - Shareware program available from HP.
- Laplink - Commercial program available from Travelling Software. PP Systems is licensed to supply one copy of Laplink with each HP Palmtop.

The following instructions refer to file transfer with Laplink. Transfile users should refer to the HP Palmtop Operator's Manual or HP for further information.

Laplink is stored in the system ROM of the HP 1000CX Palmtop Computer. A second copy will be supplied on disk if the HP computer is supplied by PP Systems. The first step is to install Laplink onto recipient PC's hard disk.

5.3.3.1. Laplink Installation.

The following procedure can be used to install Laplink.

1. Make a "link" sub-directory off the root directory by typing "**md link**" and pressing "ENTER".
2. Insert the floppy disk and switch to the floppy drive by typing "**A:**" and pressing "ENTER".
3. Copy all of the files from the floppy drive to the "link" sub-directory. Type "**copy *.* c:\link**" and press "ENTER".

5.3.3.2. Cable Connection.

Connect the Laplink Cable from the 10 pin serial connector on the right hand side of the HP palmtop to the 9 pin serial port on the PC.

5.3.3.3. Operating the Laplink Program.

It is sensible to reboot both computers before attempting to transfer files. Make sure that the desktop computer is rebooted in MS-DOS mode, as Laplink will not transfer files properly in the Windows® environment.

In the following instructions the desktop (receiving) computer is referred to as the LOCAL computer, the HP Palmtop is referred to as the REMOTE computer.

1. Goto the "link" sub-directory on the LOCAL PC by typing "**cd link**" and pressing "ENTER". Goto the root directory on the HP Palmtop (REMOTE) PC
2. Type "**llra /?**" on the LOCAL PC and press "ENTER". This will display all of the Laplink options.
3. On the LOCAL PC, type "**llra /x**" to install the program. (X refers to the COM port used on the local PC *e.g.* llra/1 designates COM1 communications, the default port).
4. On the HP Palmtop (REMOTE) PC, type "**llra /1**". A beep should sound after a few seconds to indicate that communications have been established. Laplink will map the drives on the REMOTE computer to virtual drive allocations on the LOCAL PC. If there is no beep both computers should be re-booted and steps 1 - 4 repeated.
5. From the "link" sub-directory on the LOCAL PC, type "**llra /m**" to show the remote drive allocations. Then press "ENTER".

   The following could be displayed depending on the configuration of the LOCAL PC:

LOCAL PC Virtual Drive Letters:	REMOTE PC Actual Drive Letters:
E	A
F	C

Table 3. LOCAL PC with two floppy drives and a single hard drive.

5.3.3.4. Copying Files from the REMOTE (Palmtop) to the LOCAL PC.

Files may be copied between drives and "virtual drives" on the LOCAL PC. The following example shows how to copy all the files from the A drive of the HP Palmtop to the root directory of the LOCAL PC hard disk.

Type "**copy e:*.* c:**" and press "ENTER"

This command instructs the LOCAL PC to copy contents of virtual drive E (*i.e.* the A: drive on the Palmtop) to drive C of the LOCAL PC (*i.e.* the hard drive of the LOCAL PC).

This procedure can also be used to copy files from the LOCAL PC to the HP Palmtop (*i.e.* when the system files need to be upgraded).

Once file transfer is complete it is important to uninstall Laplink on the HP Palmtop. Laplink occupies the serial port, preventing the serial communications between the UniSpec software and the instrument. Type "**llra /u**" on the palmtop and press "ENTER". Alternatively reboot the palmtop by simultaneously pressing "CONTROL ALT and DELETE".

5.4. Operating the DOS Software.

The DOS software contains all of the instrument control and data analysis features of the Windows software. Where possible similar menus and controls have been used to minimize re-learning of the software.

The main menu is automatically displayed when the UniSpec Software is loaded (Figure 35).

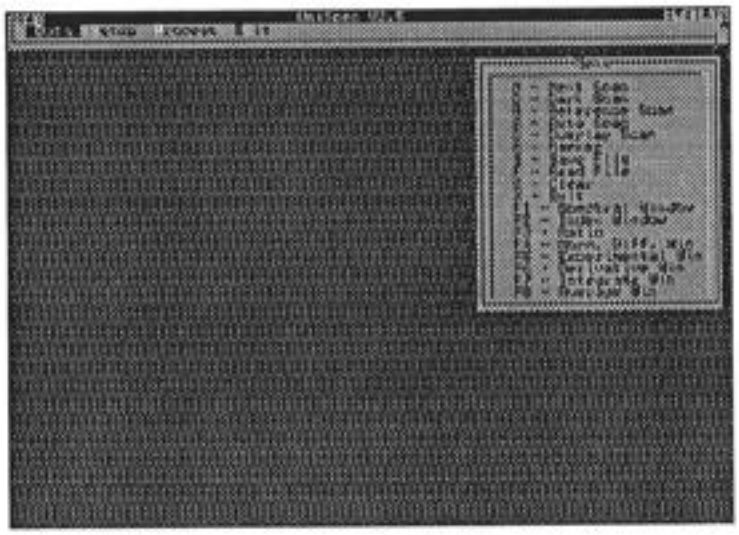

Figure 35. Main Menu of the DOS software with the Quick Menu displayed.

The system's control and configuration functions are categorized under five drop-down menus. These are accessed using accelerator keys (*i.e.* ALT + highlighted letter). Individual menu items can then be selected by either moving the high-lighted area over the option with arrow keys and pressing the "ENTER" key, or by pressing the high-lighted letter associated with each function.

Certain functions can be initiated directly by pressing "CTRL" + letter function. The software can also be configured to display a "Quick Menu" of commonly used functions and their access keys (Figure 35).

The following key functions are used to select and move within UniSpec software functions:

- TAB key (or Shift TAB) - move from one selection to another.
- Arrow keys - scan through options.
- Space bar - select/de-select check-boxes.
- Text - type text to change parameters and filenames.
- Escape key - remove current displayed menu.
- F1 - switch to Spectral Window.
- F2 - switch to Index Window.
- F3 - switch to Ratio Window.
- F4 - switch to Norm. Diff. Window.
- F5 - switch to Experimental Window.
- F6 - switch to Derivative Window.
- F7 - switch to Integrate Window.
- F8 - switch to Average Window.
- F9 - toggle between raw data and reflectance.
- F10 - toggle between full and expanded wavelength range.
- DEL - Toggle shutter.
- UP/DOWN - Toggle source.

5.4.1. Data Menu.

Instrument data acquisition and file handling options are grouped under the Data Menu. The following functions are available:

Data	
	Next Scan
	Dark Scan
	Reference Scan
	Auto Scan
	Overlay Scan
	Marker
	Save File
	Read File
	Overlay File
	Clear
	Exit

Next Scan.

This initiates a scan and presents the data in the Spectral window (Figure 36). It operates in a similar manner to the UniSpec Windows Software (Section 4.2.1.1., (Scan.)).

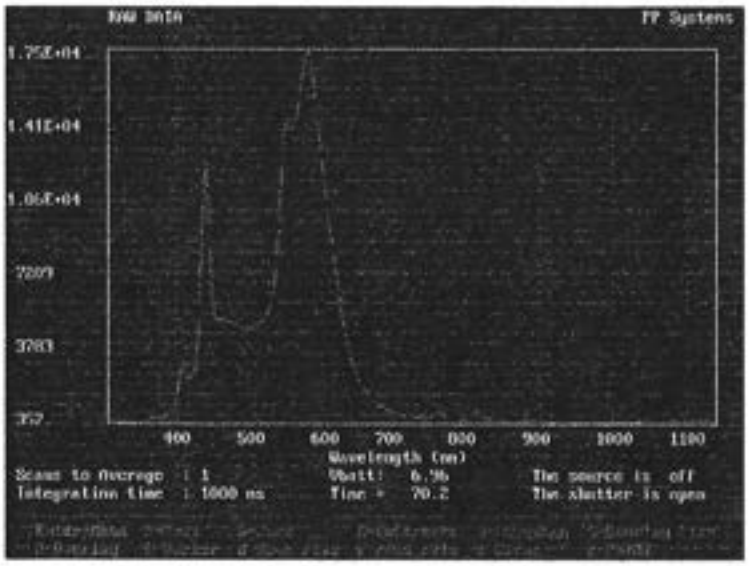

Figure 36. Captured Scan Displayed in the Spectral Window.

Further operations may be selected by pressing the appropriate letter on the PC keyboard. The halogen source may be toggled on/off by pressing the "Up" (on) and "Down" (off) arrow keys; the shutter is controlled (open/close) with the "Delete" key.

Dark Scan.

This feature initiates a dark scan (Figure 37). It operates in a similar manner to the UniSpec Windows Software (Section 4.2.1., (Dark Scan)). The dark scan is stored in PC memory, and automatically subtracted from all subsequent scans if the "Dark Correction ON" button is selected under the Options menu Section 5.4.2. (Options.).

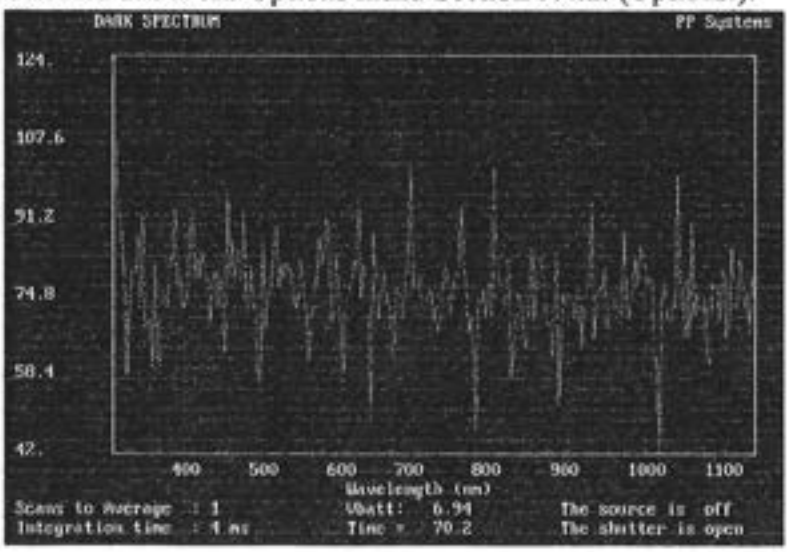

Figure 37. Dark Scan (Integration Time = 4ms).

Next Scan.

This initiates a scan and presents the data in the Spectral window (Figure 36). It operates in a similar manner to the UniSpec Windows Software (Section 4.2.1.1., (Scan.)).

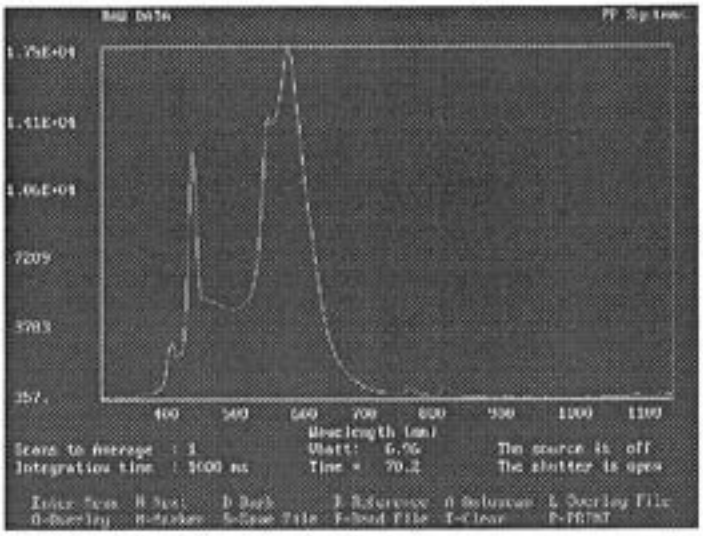

Figure 36. Captured Scan Displayed in the Spectral Window.

Further operations may be selected by pressing the appropriate letter on the PC keyboard. The halogen source may be toggled on/off by pressing the "Delete' key; the shutter is controlled with the "Up" and "Down" arrow keys.

Dark Scan.

This feature initiates a dark scan (Figure 37). It operates in a similar manner to the UniSpec Windows Software (Section 4.2.1., (Dark Scan)). The dark scan is stored in PC memory, and automatically subtracted from all subsequent scans if the "Dark Correction ON" button is selected under the Options menu Section 5.4.2. (Options.).

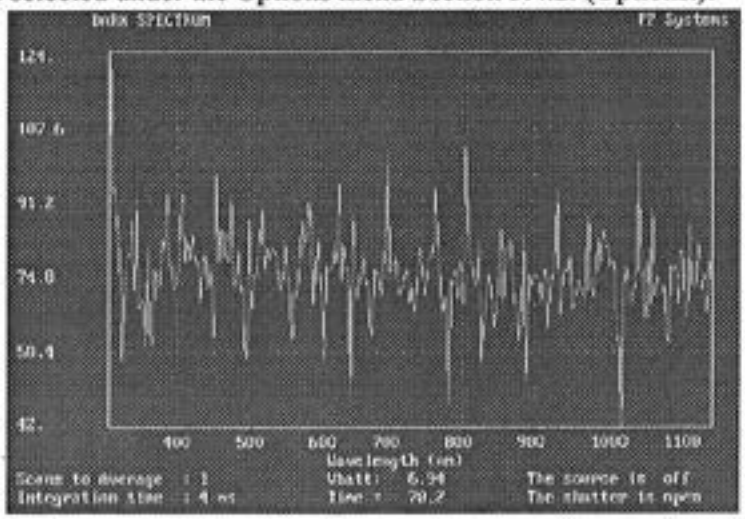

Figure 37. Dark Scan (Integration Time = 4ms).

Reference Scan.

The reference scan initiates and stores a scan for use as a reference during Reflectance and Absorbance calculations (Section 6.0., (Basic UniSpec Measurements.)). The procedure is the same as that used by the UniSpec Windows Software (Section 4.2.1.1., (Reference Scan.)).

The software can be configured to automatically present Reflectance or Absorbance by configuring the View data functions in the options dialog box (Section 5.4.2., (Options.)).

Auto Scan.

Auto scan initiates scanning, automatically capturing data at a pre-set time interval. The interval is configured in the options dialog box (Section 5.4.2., (Options.)). This function is typically used for collecting kinetic data or for rapid sampling at a set sampling frequency. It can be combined with the Auto Save function (Section 5.4.2., (Options.)) to automate data storage. The "Escape" key can be used to terminate the Auto Scan function.

Overlay Scan.

This function initiates a new scan without removing the existing plot(s) from the "Main" window. A series of up to eight scans may be displayed simultaneously. Any additional scans will replace the first scans in the series. If the Autoscale function is selected, the vertical scale will be adjusted to suit the most recent plot in the series.

The Erase function (Section 5.4.1., (Clear.)) should be used to clear the "Main" window, whilst the Marker function can be used to cursor through the spectrum in a similar manner to the UniSpec Windows Software (Section 4.2.1., (Cursor.)).

Save File.

Scans can be stored to disk using the Save File function. The following prompt box (Figure 38) requests a file name and file path for storage. All scan files are stored with the *.SPU file extension. (Older files stored with Version 2.5 or earlier of the DOS software have a *.SPT file extension. These files can only be read with Version 2.5 or lower).

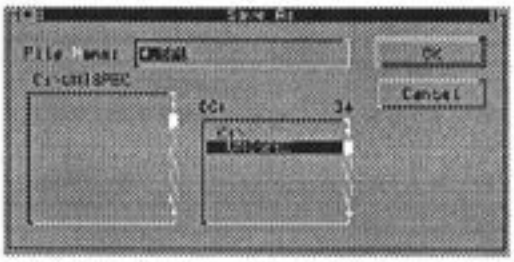

Figure 38. Save File Dialog Box.

Read File.

Previously stored scans can be read and plotted with the Read File function. The following prompt box requests the file location and file name (Figure 39).

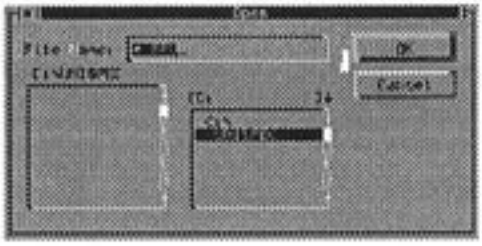

Figure 39. Read File Dialog Box.

Overlay File.

This function reads a stored file from disc without removing the existing plot from the "Main" window. A maximum of eight files may be overlaid.

Clear.

Erases on screen data and re-sets the timer to zero.

Exit.

This function terminates and closes the UniSpec software. Configuration parameters are saved to UNISPEC.INI file.

5.4.2. Setup Menu.

This drop-down menu is used to configure instrument and software settings. The following features are available:

Setup	
	Auto Set Integration Time
	Options
	Set Scale
	Instrument Parameters
	Default Data Directory
	Reference Calibration File
	Printer Options

Auto Set Integration Time.

The integration time defines the detector exposure period during each scan. Ideally the integration time should be set so that the measured signal occupies most of the instrument measurement range. The Auto Set feature sets the integration time so that the highest spectral intensity occupies 75% of the A/D range of the instrument. The longest integration time that is automatically set is 1000ms. Longer times can be set manually using the Options function below.

Options.

Most of the hardware configuration parameters are set with the Options function. The following dialog box is displayed (Figure 40):

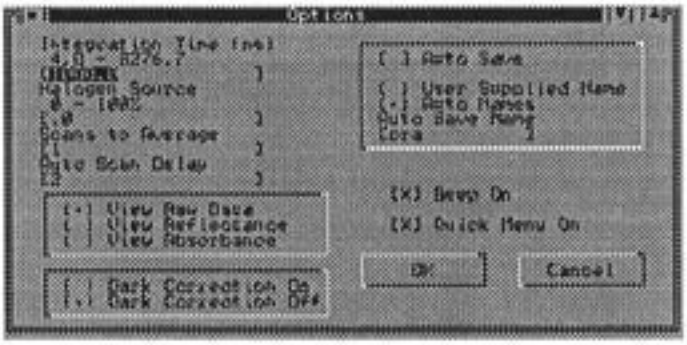

Figure 40. Options Dialog Box.

The following settings can be made. They operate in a similar manner to the UniSpec Windows Software (Section 4.2.1.2., (Options.)).

1.	Integration Time -	Defines the exposure duration of the detector (4 - 3276 ms).
2.	Halogen Source -	Controls the voltage supplied to the halogen lamp (7 - 102.3%).
3.	No. Scans to Average -	Sets the number of scans to average for a single measurement.
4.	Auto Scan Delay -	Defines the period between scans when the Auto Scan function is used.
5.	Auto Save -	Enables the instrument to automatically save scans.
6.	View Reflectance / Raw Data -	Displays the intensity values that are recorded directly from the spectrometer (0 to 65535). The Reflectance Data option displays the ratio of the present scan and a previously stored reference scan (generally 0 to 1).
7.	Dark Correction -	The Dark Current Correction automatically subtracts a previous measurement of the dark current from all subsequent scans.
8.	Beep Option -	Toggles a beep at the end of each measurement on/off.
9.	Quick Menu -	Toggles a short cut menu on/off.

Set Scale.

The Set Scale menu (Figure 41) can be used to manually set the Y-axis of all data plots for each of the data windows or switch to automatic scaling.

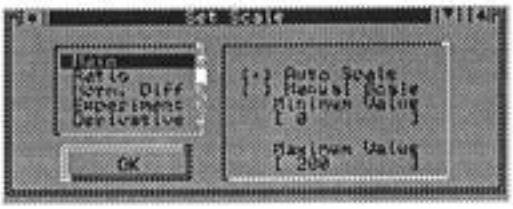

Figure 41. Set Scale Dialog Box.

Instrument Parameters.

The Instrument Parameters function lists the instrument calibration parameters (Figure 42). (Further information about these values is available in Section 4.2.1.2., (Instrument Parameters.).

Figure 42. Instrument Parameters Dialog Box.

Default Data Directory.

Specifies the path and directory where data will be stored. Saved data is automatically stored to the default directory.

Reference Calibration File.

Each scan is automatically multiplied by the reference calibration file when this option is selected. This can be used to correct a field reflectance standard to a calibrated laboratory standard. Further information can be found in Section 4.2.1.2., (Reference Calibration File.)).

Printer Options.

UniSpec software is compatible with three different printer drivers. The Printer Options dialog can be used to configure the software with the appropriate printer driver (Figure 43).

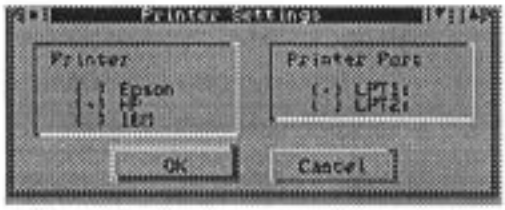

Figure 43. Printer Options Dialog Box.

One of the following printer types may be selected:

- HP Deskjet Printers,
- Epson,
- IBM.

Most other printers can be configured to emulate one of these options. See your printer manufacturer's manual for further information.

5.4.3. Process Menu.

The Process Menu contains a number of mathematical operations that can be applied to previously stored data. The following operations are available:

Process	
	Divide
	Add
	Subtract
	Multiply
	Average
	Derivative
	Transform

The basic mathematical operations (Divide, Add, Subtract and Multiply) require the user to specify two files to be used in the calculation (Figure 44). The calculated result is then presented in the Main Window.

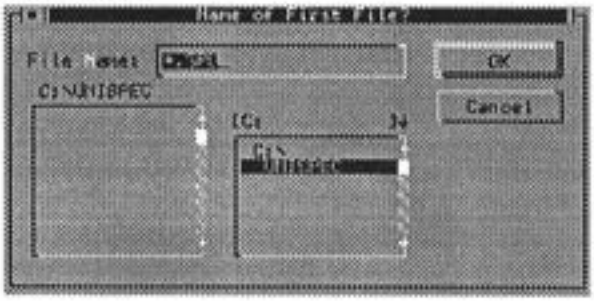

Figure 44. File Specification Dialog Box.

Multiple files may be selected for averaging with the Average function. This generates the "Files to Average" dialog box (Figure 45). The procedure for defining the files for calculation is the same used for the UniSpec Windows Software (Section 4.2.1.4., (Process.)).

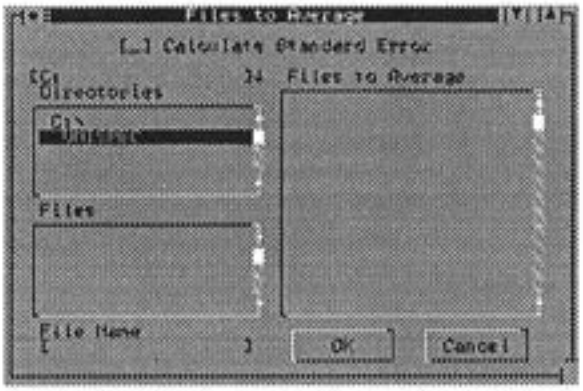

Figure 45. Files to Average Dialog Box.

The Transform feature generates the "Transform Values" dialog box (Figure 46). This is used to enter user defined parameter values from the transformation. Once complete the user is prompted to select the pair of data files that are used in the calculation.

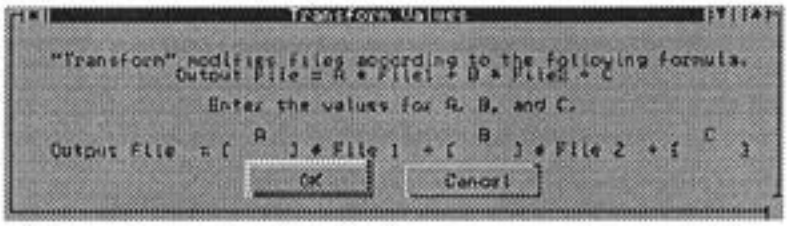

Figure 46. Transform Values Dialog Box.

5.4.4. Exit Menu.

The program can be terminated and closed using the Bye function.

5.4.5. Quick Menu.

The Quick Menu (Figure 47) provides a series of short cuts to most of the commonly used software functions. It also used to switch between data windows. The configuration and function of the different data windows are discussed in Section 5.4.6. (Automatic Calculation of User-Defined Index Data.).

Figure 47. Quick Menu.

5.4.6. Automatic Calculation of User-Defined Index Data.

The DOS software can be configured to automatically calculate user-defined index data (kinetic data) in a similar manner to the Windows software. There are however, a number of differences to accommodate the fact that DOS can only present one data screen at a time.

The Index configuration functions are located under the Options drop-down menu in the Index Window. This is displayed by pressing the "F2" key to open the Index window and then "ALT + O" to reveal the Options drop-down menu. The Index window is de-activated by pressing the "F2" key a second time.

The Options Drop-Down menu is used to configure wavelengths used in the calculations and the calculations themselves:

Options		
	Band Definitions	- define wavebands used in the calculations.
	Kinetic Definitions	- define the index index calculations.
	Close Index Window	

The procedure for defining wavelengths and index calculations is the same as the Windows software (Section 4.2.1.4., (Defining Wavelengths.)) and Section 4.2.1.4., (Defining Index Calculations (Kinetic Definitions).) respectively.

Once the calculations have been defined, they must be activated before scanning. The Activate drop-down menu is used to select the types of calculation that are made and toggle the Timestamp on/off.

Activate	
	Ratio.
	Normalized Difference.
	Experimental.
	Derivative.
	Interval.
	Average.
	Timestamp.

The calculations will automatically be made each time a scan is completed. However the DOS software cannot display all of the calculated data simultaneously in sibling Windows. As a result the Index will replace the Main Window. The F1- F8 keys can be used to choose between the different indexes.

Index data may be saved directly to disk from each data Window by pressing the "S" key (Figure 48) or by index type using the Save drop-down menu in the Index Window.

Figure 48. Ratio Index Window.

6.0. Basic UniSpec Measurements.

This chapter is intended to serve as a basic tutorial to the main types of measurement that can be made with UniSpec. The main types of measurement are:

- Spectral Measurements.
- Reflectance.
- Transmission.
- Absorption.

Application-specific information can be found in various "Application Notes" that are available from PP Systems.

6.1.Spectral Measurements.

UniSpec may be used to measure spectral quality. Typical applications include examination of light sources, ground truthing and remote sensing.

Procedure:

1. Point the foreoptic at the sample under investigation.
2. Adjust the integration time (Section 4.2.1.2., (Auto Set Integration Time.)).
3. Cover the end of the fiber optic and take a "dark scan" (Section 4.2.1.1.,.(Dark Scan.)).
4. Switch on the "dark correction" to compensate for any dark current in the detector (Section 4.2.1.1., (Dark Scan.)).
5. Scan the sample (Section 4.2.1.1., (Scan.)).

An optional cosine receptor is available to measure incident radiation. This consists of a white perspex diffuser that is mounted in a black acetal block. The block fits over the foreoptic (Figure 49) and is secured in position with a thumbscrew.

Figure 49. Cosine receptor.

6.2. Reflectance Measurements.

Reflectance measurements are used in diverse applications from industrial quality control to plant physiology. During the measurement, a sample is illuminated with a constant light source. The reflectance from the sample is compared to that of a previously recorded, calibrated white reference standard.

Procedure:

1. Set up the instrument hardware (Section 3.2., (Setting Up UniSpec Hardware.)).
2. Turn on the instrument.
3. Adjust the lamp intensity to 100% using the instrument toolbar (Section 4.2.2.13., (Halogen Source Scroll Bar.)).
4. Adjust the integration time (Section 4.2.1.2., (Auto Set Integration Time.)).
   The instrument must be setup so that the reflected light from the brightest object to be scanned (typically the white reflectance standard) does not saturate the detector. This can be done by inserting the reference standard in the measuring position and clicking the "Auto" button on the instrument toolbar (Section 4.2.2.16., ("Auto" Button.)).
5. Close the instrument shutter to prevent light from the source reaching the detector with the "Shutt" button on the instrument toolbar.
6. Take a "Dark Scan" (Figure 50) using the "Darkscan" button (Section 4.2.2.6., ("Darkscan" Button.)).and switch on the "Dark Correction" with the "Darkcorr" button (Section 4.2.2.10., ("Darkcorr" Button.)).

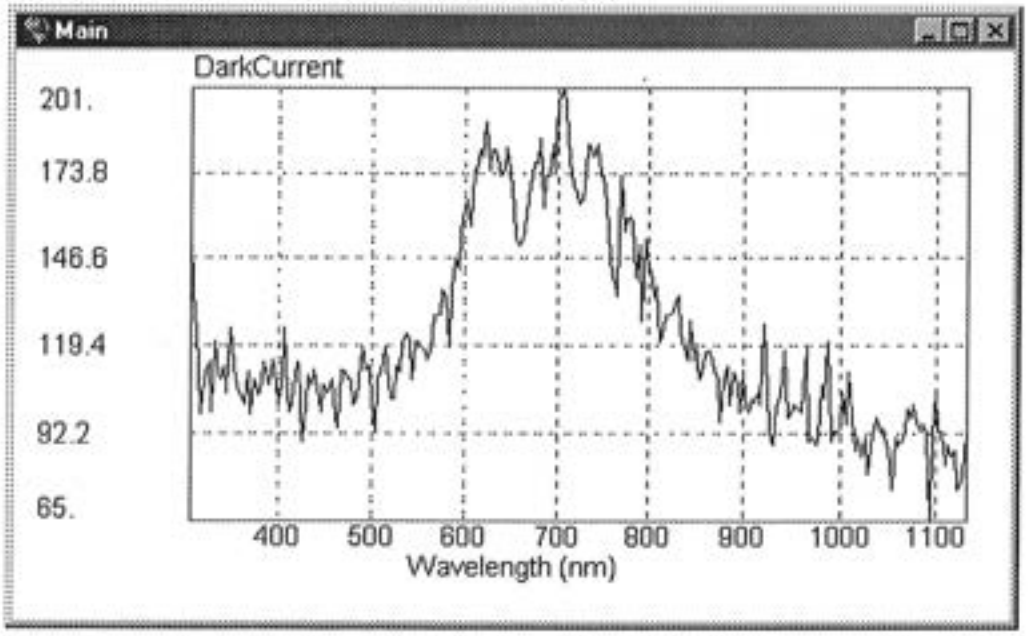

Figure 50. Typical Dark Scan (Integration Time = 100ms).

7. Open the shutter with the "Shutt" button on the instrument toolbar.
8. Insert the reference standard into the fiber-optic retainer (*e.g.* standard clip).

9. Take a reference scan (Io) by pressing the "Reference" button on the instrument toolbar (Section 4.2.2.7., ("Reference" Button.)) (Figure 51).

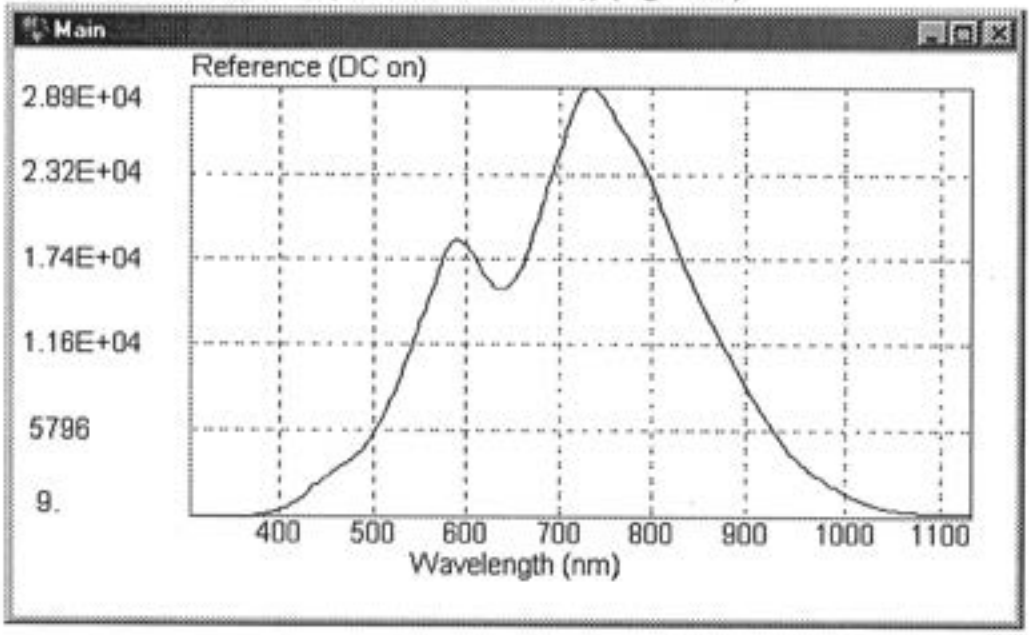

Figure 51. Typical Reference Scan (Integration Time = 100ms, Source = 80%).

10. Remove the reference standard from the fiber-optic retainer.
11. Insert the sample into the fiber-optic retainer.
12. Take a scan (I) by pressing the "Scan" button (Section 4.2.2.1., ("Scan" Button.)) (Figure 52).

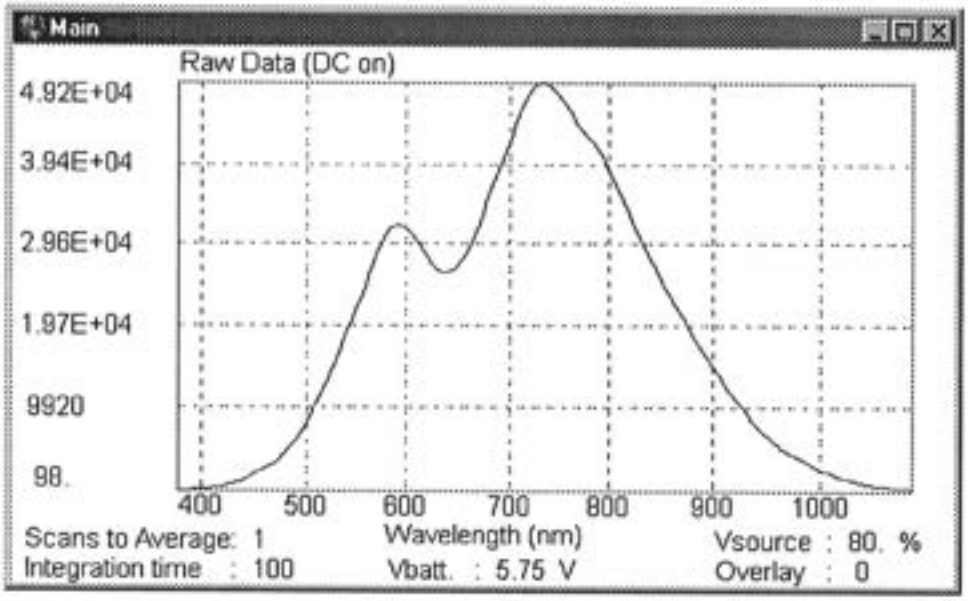

Figure 52. Raw Scan Data from a Yellow Piece of Paper.

13. Plot reflectance (I/Io) by selecting "REFL" with the "Refl/Raw" button (Section 4.2.2.9., ("Abs/Refl" Button.)) (Figure 53).

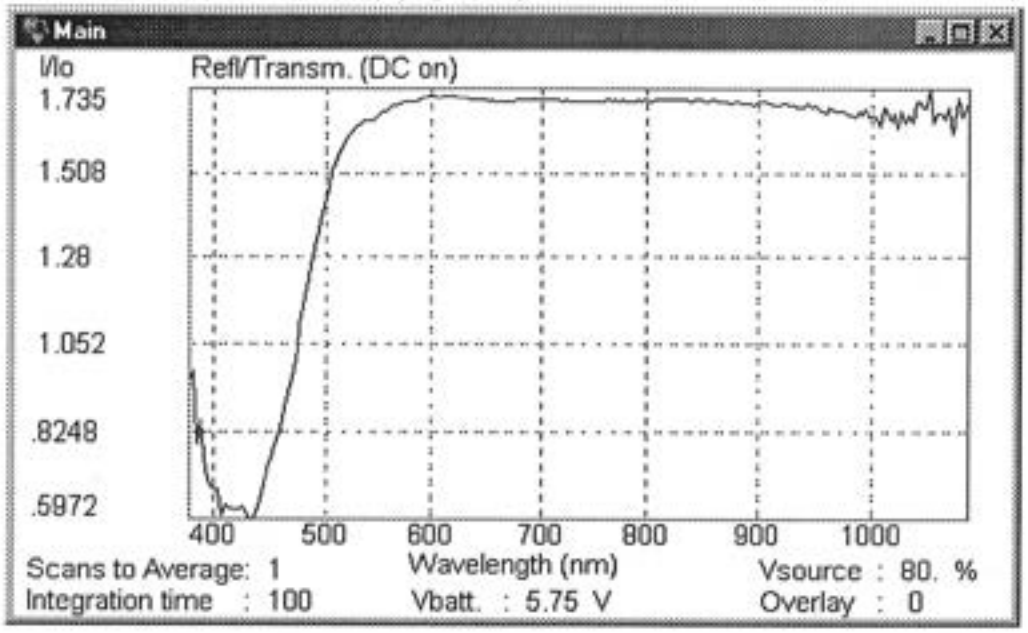

Figure 53. Reflectance Scan From a Yellow Piece of Paper.

It is important to appreciate that the accuracy of the reflectance measurement is due in part to the accuracy of the reference standard. As a result it is important to keep the reference free from dirt and other contamination such as skin oils. The guidelines below should be followed:

6.2.1. General Care of the Reference Standard.

The reference standard is made from a very durable material. However, care should be taken to avoid contaminants such as finger oils from contacting the material surface. Always wear clean gloves whilst handling the standard and keep it free of dirt and dust. It is recommended that the base and sides of the standard be surrounded in a container or foil to protect it in use. The standard should be stored in a protective holder when not in use.

6.2.2. Cleaning the Reference Standard.

If the standard is lightly soiled, it may be air brushed with a jet of clean dry air or nitrogen. Do NOT use freon. For heavier soil, the material can be cleaned by sanding under running water with a 220-240 grit, waterproof emery cloth until the surface is totally hydrophobic (water beads that run off immediately). Blow dry with clean air or nitrogen or allow the material to air dry.

6.3. Transmission/Absorption Measurements.

During transmission/absorption measurement, the sample spectra (I) is compared to a reference spectra (Io) that is obtained without the sample in position. In UniSpec software transmission is calculated as I/Io and absorption as LOG I/Io. Transmission measurements can be made using either PP Systems sample cuvette holder or the absorbance/transmission probe.

The following procedure is based around the PP Systems sample cuvette holder. It may be modified to suit custom apparatus.

Procedure:

1. Set up the instrument hardware (Section 3.2., (Setting Up UniSpec Hardware.)).
2. Turn on the instrument.
3. Adjust the lamp intensity to 100% using the instrument toolbar (Section 4.2.2.13., (Halogen Source Scroll Bar.)). Neutral density filters can be inserted in the cuvette to prevent the spectrometer from being saturated.
4. Adjust the integration time (Section 4.2.1.2., (Auto Set Integration Time.)).
   The instrument must be setup so that light transmission through the empty cuvette does not saturate the detector. This can be done by inserting the empty cuvette into the cuvette sample holder and clicking the "Auto" button on the instrument toolbar (Section 4.2.2.16., ("Auto" Button.)).
5. Close the instrument shutter to prevent light reaching the detector with the "Shutt" button on the instrument toolbar.
6. Take a "Dark Scan" using the "Darkscan" button (Section 4.2.2.6., ("Darkscan" Button.)) and switch on the "Dark Correction" with the "Darkcorr" button (Section 4.2.2.10., ("Darkcorr" Button.)).
7. Open the shutter with the "Shutt" button on the instrument toolbar.
8. Insert the empty cuvette or reference into the cuvette sample holder.
9. Take a reference scan (Io) by pressing the "Reference" button on the instrument toolbar (Section 4.2.2.7., ("Reference" Button.)).
10. Remove the reference standard from the cuvette sample holder.
11. Insert the sample into the cuvette sample holder.
12. Take a scan (I) by pressing the "Scan" button (Section 4.2.2.1., ("Scan" Button.)).
13. Plot transmission (I/Io) by selecting "REFL" with the "Refl/Raw" button (Section 4.2.2.2., ("Refl/Raw" Button.)).
14. To view absorption select "ABS" with the "Abs/Refl" button (Section 4.2.2.9., ("Abs/Refl" Button.)).

7.0. Maintenance.

The UniSpec should require minimal maintenance. There are three items that may eventually require maintenance or replacement. These are:

- Internal Halogen Source (D, Figure 54),
- Battery (E, Figure 54),
- Fuse (A, Figure 54).

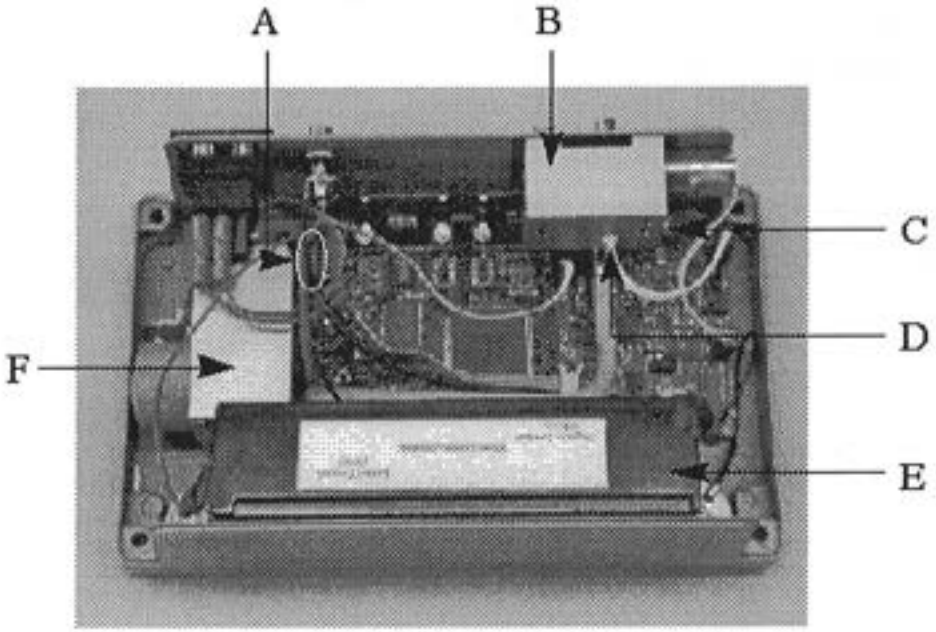

Figure 54. Internal UniSpec Layout Showing: F1 Fuse Location (A), Light Source Housing (B), Light Source Retaining Screw (C), Light Source (D), Battery (E) and Spectrometer (F).

7.1. Internal Halogen Source.

The average lifetime of the halogen source is around 1500 hours when operated at maximum output (102%). However, the spectral quality of the lamp can change as it nears the end of its life. It is therefore recommended that the lamp be replaced after 1000 hours of use. This also minimizes the risk of lamp failure during a series of measurements.

Lamp life is not extended by operation at reduced output. In fact operation at low intensities reduces life and causes a spectral shift towards longer wavelengths.

The procedure for replacing the lamp is:

1. Switch off the instrument and allow it to cool down. (The lamp housing may be warm if the internal lamp has been extensively used).
2. Turn the UniSpec over and remove the four screws at each corner of the base. Then return the instrument to its normal orientation, taking care not to separate cover and base.
3. Gently remove the aluminum cover by sliding it upwards. Some force might be needed, if the cover sticks to the base. Be careful not to stretch the fan-wire connecting cover and base.
4. Locate the light source (B, Figure 54).
5. The source is held in place by a retaining screw (C) in the side of the lamp housing (B). Turn this screw anti-clockwise to loosen it.
6. Gently slide the source out of the lamp housing socket. Note the orientation of the lamp connector leads on the circuit board. Disconnect the lamp connector leads from the circuit board.
7. Connect the replacement lamp to the circuit board pins. **Take care to avoid touching the lamp lens**. If the quartz envelope was touched, or otherwise contaminated, clean it with alcohol.
8. Gently slide the source into the lamp housing so that the end of the source housing is flush with the lamp housing. If the source is pushed in too far it will obstruct the shutter.
9. Secure the source in position by tightening the retaining screw on the side of the lamp housing. Place some white out on the screw to prevent it from loosening.
10. Re-fit the aluminum cover, flip the instrument over and insert the four screws.

7.2. Battery.

The internal battery will gradually degrade with age and use. Eventually it will hold less charge and require more frequent charging. The useful life can be several years, if it is recharged after each use. However, the battery can be ruined if it is left in a discharged state for a prolonged period of time. In this situation, the battery enters an irreversible deep-discharged state and it must be replaced.

The procedure for replacing the battery is:

1. Switch off the instrument and allow it to cool. Turn the UniSpec over and remove the four screws in each corner of the base.
2. Gently remove the aluminum cover by sliding it upwards. Some force might be needed if the cover sticks to the base. Be careful not to stretch the fan-wire connecting cover and base.

3. The battery is attached to the base with a Velcro strap. Disconnect the battery leads and remove it by gently prying it upwards with a screwdriver against the case. Care should be taken to avoid dislodging any wires in the vicinity of the battery or prying against the circuit board or spectrometer.
4. Fit the replacement in the correct orientation, taking care not to pinch any wires between components. Re-attach the battery leads. The RED lead goes to the positive terminal, the BLUE lead goes to the negative terminal.
5. Re-fit the aluminum cover, turn the instrument over and re-fit the four screws.

It is important to connect the battery in the correct polarity. The fuse will blow if the polarity is accidentally reversed. This should be checked if the instrument fails to start following battery replacement.

7.3. Fuse.

UniSpec is protected by a 5A fuse (Figure 54). The fuse could blow for a variety of reasons (*e.g.* reverse connection of the battery or a short circuit).

The fuse can easily be replaced with the following procedure:

1. Allow the instrument to cool down .
2. Turn the UniSpec over and remove the four screws at each corner of the base.
3. Gently remove the aluminum cover by sliding it upwards. Some force might be needed if the cover sticks to the base. Take care not to stretch the fan-wire connecting cover and base.
4. Disconnect the battery charger (if connected) and the battery terminals.
5. Locate the fuse on the circuit board (A, Figure 54). (Older UniSpec systems may have an in-line fuse located on one of the battery leads).
6. Grasp the fuse with needle nose pliers and gently pull it upward to remove it from the fuse holder.
7. Grip the replacement fuse, bend and cut the leads, and gently insert it into place. It is held in position by spring contacts. The orientation of the fuse is unimportant.
8. Re-connect the battery terminals and re-fit the aluminum cover.

If replacement fuses blow, there is probably a hardware fault in the electronics. Contact PP Systems for further information.

© 1999, PP Systems

8.0. Troubleshooting.

The following table covers the most commonly encountered problems that UniSpec operators have reported. Further technical assistance may be obtained from PP Systems.

Fault:	Probable Cause:	Remedy:
UniSpec fails to communicate with the PC.	➢ Cable not connected properly.	Check RS232 connection at both UniSpec & PC ends. (Section 3.2.2., (Data Connection to the PC.)).
	➢ UniSpec not switched on.	Check that UniSpec is running. The green LED should be flashing. (Older instruments do not have an LED).
	➢ Wrong COM port configuration.	The COM port must be free of other drivers. Change the COM port settings (Section 4.2.1., (Instrument Parameters.)).
HP Palmtop computer locks up and only responds to a reboot (CTRL+ALT+DEL)	➢ UniSpec battery discharged.	Recharge battery or operate with charger fitted.
	➢ Palmtop AA batteries flat.	Replace AA batteries.
Warning Message: "No Data Transmitted"	➢ Serial cable has become disconnected.	Check RS232 connection at both UniSpec & PC ends.
	➢ Windows software running twice.	Close software & repeat start-up procedure.
	➢ UniSpec switched off (LED off).	Switch on UniSpec & repeat start-up procedure. LED should be flashing before starting program.
	➢ Wrong COM port selected.	Change COM port settings (Section 4.2.1.2., Instrument Parameters.)).
	➢ Battery discharged and charger not connected (LED off).	Plug in charger.

UniSpec is not powered (LED fails to illuminate).	➢ UniSpec switched off. ➢ Battery discharged and charger not connected. ➢ Internal fuse blown.	Switch on the UniSpec. Plug in charger. Replace Fuse. (Section 7.3., (Fuse.)).
Low Intensity Scans.	➢ Lamp shutter closed. ➢ Lamp not functioning (reflectance/absorbance measurements). ➢ Fiber-optic disconnected. ➢ Damaged fiber-optic. ➢ Sample not properly aligned. ➢ Integration time set too low. ➢ Scan average set too low. ➢ Insufficient illumination.	Open lamp shutter. Switch on lamp and replace if necessary. (Section 7.1., (Internal Halogen Source.)). Connect fiber-optic. Conduct fiber-optic test. (Appendix A.) Center sample with holder or clip until it fills the fiber-optic's field of view. Increase integration time. (Section 4.2.1.2., (Options.)). Increase scan averaging. (Section 4.2.1.2., (Options.)). Check lamp function or move sample closer to the fiber-optic.
"Reflectance" shows no data.	➢ No "reference" scan was performed.	Perform a "reference" scan and repeat measurement.
Reflectance scan has steep changes at the spectrum extremes.	➢ No "dark" scan was performed.	Perform a "dark" scan and repeat measurement.
Spectral signal is very noisy (curves are not smooth).	➢ Integration time too short.	Insufficient light to obtain accurate measurement.

Table 4. UniSpec Troubleshooting Table.

Appendix A. Fiber Optic Test.

The UniSpec fiber optics are designed to be as robust as possible. However, fiber optics are breakable and should be treated with care.

Each fiber optic comprises many individual fibers; breakage will reduce transmission and attenuate signal. A more significant problem is that broken fibers may cause erratic light transmission that varies with slight movements of the fiber optic probe. Erroneous calculations of reflectance/absorbance will be made if the fiber transmission changes between making the reference and sample measurements. As a result the following practices are recommended to protect the fiber:

- Always coil the fiber as loosely as possible. **Never** force a fiber to bend in a tight radius.
- Pay particular attention to minimize bending at the fiber optic ends.
- Always move the fiber optic as gently as possible. When walking with the instrument keep an eye on the fiber and avoid catching it on objects.
- Always store the fiber optic in a padded container or bag when not in use.
- Avoid closing the lid of the UniSpec carrying case onto the fiber optic.
- Protect fiber ends with the rubber caps that are supplied.

Testing Fiber Optic Integrity.

The fiber optics can be tested by taking a series of scans of a reference standard, gently bending or moving the fiber between each scan. After the first scan use the overlay function to superimpose subsequent scans. The series of scans should overlay as a single spectrum. Damaged fiber optics typically show changes in the spectra as the movement of the fibers causes the transmission to change.

Unfortunately it is not possible to repair fiber optics. They must be replaced.

© 1999, PP Systems

Appendix B. Technical Specifications.

The UniSpec is available with a number of different types of detectors:

Detector Type	**VIS / NIR**	**UV / VIS**	**UV**
Optimal Sensing Range	300 - 1100nm	190 - 730nm	190 - 400nm
Raleigh Resolution	<10nm	<7nm	<3nm
Bin Size	3.3nm	2.1nm	0.8nm
Absolute Accuracy	<0.3nm	<0.2nm	<0.2nm

The VIS/NIR detector is available in three different versions:

UV Enhanced - increased sensitivity in the UV range (300-400nm),
VIS Enhanced - increased sensitivity in the VIS range (400-550nm),
NIR Enhanced - increased sensitivity in the NIR range (875-1000nm).

Repeatability	Within 0.1%
Scan Time	<0.5 second (plus integration time)
A/D Converter	16 bit (dynamic range of 65,536 A/D counts)
Integration Time	4 - 32,767ms (longer times optional)
Light Source	Integral 7.0W halogen bulb
Digital Output	RS232 (19.2Kbaud)
Power	Integral 6V 3.4Ah lead acid battery • 35 hours with lamp off • 2 hours with continuous lamp use
Operating Temp.	0 - 45°C (non-condensing)
Dimensions	19.5cm long x 11.5cm wide x 7.5cm high
Weight	2.3Kg

© 1999, PP Systems

Appendix C. UniSpec Spares & Accessories.

Unispec Detectors...

Part No:	**Item:**
UNI001	300 - 1100 nm, VIS/NIR (UV Enhanced)
UNI002	300 - 1100 nm, VIS/NIR (VIS Enhanced)
UNI003	300 - 1100 nm, (NIR Enhanced)
UNI004	190 - 730 nm, UV/VIS
UNI005	190 - 400 nm, UV

Data Acquisition & Analysis Software for HP Palmtop PC (DOS)...

UNI200	LeafSpec Software Package
UNI250	UniWin Software for UniSpec.

UniSpec Accessories...

UNI300	HP 1000CX Palmtop Computer Includes: 4 MB RAM, Adapter and Serial Cable
UNI430	External Battery Pack
UNI435	Cosine Receptor
UNI440	Sample Holder (for absorbance/transmittance)

Foreoptics...
(for reflectance)

UNI400	Standard Foreoptic, 2.3mm D (Fused Silica)
UNI402	Standard Foreoptic, 2.3mm D (Quartz)
UNI410	Mini Foreoptic, 0.5mm D (Fused Silica)
UNI411	Mini Foreoptic, 0.5mm D (Quartz)

(for absorbance/ transmittance)

UNI600	Straight Foreoptic, 20 inches (Fused Silica)
UNI610	Straight Foreoptic, 20 inches (Quartz)
UNI615	Straight Foreoptic, 40 inches (Fused Silica)
UNI620	Straight Foreoptic, 40 inches (Quartz)

© 1999, PP Systems

UNI625	Straight Foreoptic, 80 inches (Fused Silica)
UNI630	Straight Foreoptic, 80 inches (Quartz)

Leaf Clips...

UNI500	Standard Clip (for use with UNI400 & UNI401 foreoptics).
UNI501	Mini Clip (for use with UNI410 & UNI411 foreoptics).
UNI511	Experimental Clip (for use with UNI400 & UNI401 foreoptics)

Transmission / Absorption Probes (UV/VIS)...

UNI450	Transmission / Absorption Probe (UV / VIS), includes 10mm path length tip.

Replaceable Tips...

UNI451	2 mm Path Length
UNI452	5 mm Path Length
UNI453	10 mm Path Length
UNI454	20 mm Path Length

Transmission / Absorption Probes (VIS/NIR)...

UNI550	Transmission / Absorption Probe (VIS / NIR), includes 10mm path length tip.

Replaceable Tips...

UNI551	2mm path length (UV / VIS)
UNI552	5mm path length (UV / VIS)
UNI553	10mm path length (UV / VIS)
UNI554	20mm path length (UV / VIS)

UniSpec Reference Standards...

UNI420	Uncalibrated Reference Standard, White (1¼" Disc)
UNI421	Calibrated Reference Standard, White (1¼" Disc)
UNI422	Uncalibrated Reference Standard, White (5" Square) (With Tripod Mounting).
UNI423	Calibrated Reference Standard, White (5" Square)

(With Tripod Mounting).

UniSpec Spares...

UNI502	Lead Acid Battery (6V, 3.4Ah)
UNI503	Power Supply (7.5VDC @ 2A)
663760	Power Cable (U.S.)
6637087	Power Cable (Foreign)
L1041	Halogen Bulb
STD070	RS232 Ribbon Cable
903586M	UniSpec - HP Palmtop Interface Cable
903586	HP Laplink Cable
VGC13S	Carrying Case
STD053-2	2A Fast Blow Fuse for older Unispec (Qty. of 5)
STD053-5	5A Fuse (Qty. of 5)
251005	5A Fuse (PCB Type)

© 1999, PP Systems

Appendix D. Glossary of Terms.

The following terms are used throughout this manual. This glossary is provided to clarify definitions and their relation to the UniSpec Spectral Analysis System.

Term:	*Definition:*
*.SPT	Default file extension used to identify UniSpec data. (Only used in software version 2.5 and earlier).
*.SPU	Default file extension used to identify UniSpec data.
*. TMP	Temporary index file. This is used to temporarily store index data until a user specified index file is created.
*. INI	UniSpec configuration file containing software settings .
ADC	See analog to digital converter.
Analog to digital converter	Device for converting an analog signal, such as a voltage output, to a digital (numeric) signal for processing by a computer
Average	Defined as the sum of the data sets / number of data sets.
Band	See Waveband.
Bin Size	Each photodiode in the array is exposed to a discrete band of wavelengths. The bin size is defined as the difference between the longest and shortest wavelengths in the range.
Calibration File	File used to correct a spectral scan. UniSpec Software allows the user to define a Reference Calibration File that is used to correct reflectance values calculated with a field standard to values calculated with a calibrated laboratory standard (Section 4.2.1.2., (Reference Calibration File.)).
Counts	The ADC digitizes the analogue signal from each detector in the array. The units of the raw digitized signal are often described as counts. UniSpec features a 16-bit ADC. Thus the maximum number of measurable counts is 2^{16} or 65,536.
Derivative	Slope of the spectra.

File Extension	Each DOS filename has a three character suffix to identify type. This suffix is the file extension. UniSpec Software uses *.SPT, *.INI and *.TMP files.
Fiber Optic	Flexible light guide typically made of glass, plastic or quartz fibers sealed in a plastic casing.
Foreoptic	Any optic device attached to the UniSpec detector.
Index (plural: indices)	User-defined mathematical operation carried out on defined wavebands of a spectrum.
Infrared (IR)	Region of the electromagnetic spectrum between approximately 700nm and 1mm. This can be further sub-divided into the near-infrared (700-1300nm), mid-infrared (1300-3000nm) and thermal infrared (3000nm to 1mm).
Integration Time	The duration that the photodiode array is exposed to light during measurement. This is comparable to the "exposure time" when operating a photographic camera.
Nanometer (nm)	Unit of distance equivalent to 10^{-9}m.
Near-infrared (NIR)	See infrared.
Normalize	The process of multiplying a set of data by a constant factor to make their sum (or the sum of related quantity) one.
Photo Diode Array (PDA)	UniSpec contains a series of photodiode light detectors that are connected into an array. The incoming light is diffracted off a curved grating onto an array of 256 photodiodes.
Photosynthetically Active Radiation (PAR)	Refers to the portion of the electromagnetic spectrum that is utilized by the photosynthetic apparatus for photosynthesis. Typically this is 400-700nm.
Raleigh Resolution	Defined by the capability of the spectrometer to resolve two lines in a spectrum.
Raw Scan	Measured spectral signal (*i.e.* counts versus wavelength) prior to mathematical correction or processing.
Reflectance	The ratio of the flux reflected by a surface to the incident flux.
Reflectance Standard	A highly reflective material that reflects close to 100% of incident

	flux. Standards can be calibrated to correct for losses; such standards are used to determine the incident flux on a target during reflectance measurement.
Spectrum	Plot of intensity versus frequency or wavelength.
Ultraviolet (UV)	Region of the electromagnetic spectrum below the violet end of the visible spectrum. Often subdivided in UVA (400-320nm), UVB (320-300nm), UVC (300-200nm) and vacuum UV (>200nm).
Visible Radiation	Region of the electromagnetic spectrum that is visible to the human eye (approximately 400-700nm). Often classified into the blue (400-500nm), green (500-600nm) and red (600-700nm).
Waveband	User-defined region of the spectrum.
Wavelength	Distance between successive peaks (or troughs) of a wave.

© 1999, PP Systems